SOCIO-ECONOMIC IMPACT OF FORAGE DEVELOPMENT ON FARM HOUSEHOLDS LIVELIHOOD IN MIESO DISTRICT, WEST HARARGHE ZONE, OROMIA NATIONAL REGIONAL STATE

M. Sc. Thesis

IBRAHIM AHMED

January, 2012

Haramaya University

SOCIO-ECONOMIC IMPACT OF FORAGE DEVELOPMENT ON FARM HOUSEHOLDS LIVELIHOOD IN MIESO DISTRICT, WEST HARARGHE ZONE, OROMIA NATIONAL REGIONAL STATE

A Thesis submitted to the school of Agricultural Economics and Agribusiness, Department of Agricultural Economics, School of Graduate Studies
HARAMAYA UNIVERSITY

In Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE IN AGRICULTURAL (AGRICULTURAL ECONOMICS)

By
Ibrahim Ahmed

January, 2012
Haramaya Universit

SCHOOL OF GRADUATE STUDIES
HARAMAYA UNIVERSITY

As members of the Examining Board of the Final M Sc thesis defense, we certify that we have read and evaluated the thesis prepared by: **Ibrahim Ahmed** entitled:"**SOCIO-ECONMIC IMPACT OF FORGE DEVELOPMENT ON FARM HOUSEHOLDS LIVELIHOOD IN MIESO DISTRICT, WEST HARARGHE ZONE, OROMIA NATIONAL REGIONAL STATE"** and recommended it be accepted as fulfilling the thesis requirement for the degree of: Master of Sciences in Agriculture (**Agricultural Economics**).

_____	_____	_____
Name of Chairperson	Signature	Date
_____	_____	_____
Name of Internal Examiner	Signature	Date
_____	_____	_____
Name of External Examiner	Signature	Date

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the Council of Graduate Studies (CGS) through the Departmental Graduate Committee (DGC) of the Department of Agricultural Economics

I hereby certify that I have read this thesis prepared under my direction and recommended that it be accepted as fulfilling the thesis requirement.

Jema Haji (Ph.D.)	_____	_____
Name of Major Advisor	Signature	Date
Berhanu Gebramedhin	_____	_____
Name of coo Advisor	signature	date

DEDICATION

This thesis work is dedicated to my wife Nefisa Aliyi Mohammed for taking care of my lovely kids Urji, Hanan, Biftu and Sora during my absence and for her gift, the newly born baby Beken.

STATEMENT OF THE AUTHOR

I hereby declare that this thesis is my bonafide work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an advanced M. Sc degree at Haromaya University and is deposited at the University Library to be made available to borrowers under the rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the School of Graduate Studies when in his judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

Name: _____ Signature: _____

Place: Haramaya University, Haromaya

Date of Submission: _____

BIOGRAPHICAL SKETCH

The author was born in West Hararghe zone of Oromia National Regional State, Mesala district, Gorore Saqaude town, on April 15, 1969. He attended his elementary school at Gorore Primary School and junior secondary education at Mesala Junior Secondary School and high school education at Hirna High School. After completing his high school education in 1987/88 he joined the then Haromaya University of Agriculture in September 1988 and successfully completed his BSc. Degree in Animal Science in 1991.

Immediately after graduation, he was employed in former West Hararghe Zone, Oromia National Regional State under Ministry of Agriculture and served for 17 years at different positions. At his working stays he had worked for different governmental and non-governmental organizations in various capacities.

In 2008, he joined Haromaya University to pursue his post graduate studies in the Department of Agricultural Economics, after taking one semester preparatory courses in 2007.

ACKNOWLEDGEMENTS

First of all, I am highly grateful to Allah that bestowed me good health and courage for accomplishing this research work. Also, I would like to express my sincere appreciation and gratitude to Dr. Jema Haji, whose inspiring guidance, encouragement, and understanding have vitally contributed to this study. Also, I am most grateful to my co-Adivsors, Dr. Berhanu Gebremedin, Dr. Azage Tegegn and W/r Birke Eneyew, Akiliu Bogale, Tigist Endashew and all ILRI staff members for the moral support, encouragement and initiating idea of this study opened a magnificent field of work to me.

I would also like to express my profound gratitude to IMPS of Ethiopian farmers' project for financing my study and West Hararghe Pastoral Development Desk Office (WHPODD) for paying me my salary in the course of the study. Also, I am thankful to Haromaya University, College of Agriculture, in particular Agricultural Economics Department staff members for all their support and kindness. I especially want to thank Dr. Bekebel Fufa for his supports, Mr. Gamoraw, Mr. Fekadu Gelaw, Mr. Adem kedir and Mr. Feresenbet Zeleke for their moral support, encouragement and kindness while taking preparatory courses in Agricultural economics.

Also my special thanks go to my colleagues Mrs. Adem Feto, Shibru Tesema and Alemu Tolemariam for their support in computer application. In particular, I would like to thank my family members for their support and encouragement during the course of this study, especially to my son Beken for his love and jocks when I am in hard condition. Also, I acknowledge the help provided by the Gamechis and Dadhi Gerashe, Adgo Tesaw and Zewdu Ayele IPMS of Ethiopian farmers' projects Mieso Woreda pilot learning site members and for all Mieso Woreda pastoral development offices members for their providing me important information from their offices. In this respect, I am grateful to Mabratu Wubeshte, Sadik Ahmed, Shawul Yematework, Abduleziz Seid, Abinete Ketema, Negaso, Husen, Amdu Tadese, Zerihun Mariye, Tofik Mohamad and Azmara Teshome for their assistance during the data collection process.

Finally, I thank the sample farmers from Mieso district for their patience and providing me reliable and necessary information needed for my study.

ACRONYMS AND ABBREVIATIONS

APREM	Agency for Promotion of Entrepreneurship of the Republic of Macedonia
CSA	Central Statistical Authority
FHH	Female Headed Household
GEF	Global Environment Facility
HDI	Human Development Index
ICT	Information and Communication Technologies
ICT4D	Information and Communication Technologies for Development
ICT4E	Information and Communication Technologies for Education
IFC	International Finance Corporation
IFAD	International Fund of Agricultural Development
ILRI	International Livestock Researches Institute
IPMS	Improving Productivity and Market Successes of Ethiopian Farmers
IT	Information Technology
LDC	Less Developed Countries
MDGs	Millennium Development Goals
MHH	Male Headed Household
MWIPMSPLS	Mieso Woreda Improving Productivity and Market successes Pilot Learning Site
MPU	Man Power Unit
MOA	Ministry of Agriculture
MOARD	Ministry of Agriculture and Rural Development
MOFED	Ministry of Finances and Economic Development
MVP	Marginal Value Product
MWOPRD	Mieso Woreda Offices of Pastoral and Rural Development
MOFAPCDP	Ministry of Federal Authority Pastoral Community Development Project
NBE	National Bank of Ethiopia
NGO	Non-government Organization
OLS	Ordinary Least Squares
OECD	Organization for Economic Cooperation and Development
PRA	Participatory Rural Appraisal
PSM	Propensity Score Matching

SEPI	Socio-economic Performance Indicators
SPSS	Statistical Package for Social Sciences
TGMD	Total Gross Margin Distribution
UNPFA	United Nations Population Funding Agencies
UNDP	United Nations Development Program
UNESCO	United Nations Education Scientific and Cultural Organization
UNICEF	United Nations Children Fund
USAID	United State Agency for International Development
VIF	Variance Inflation Factor
WBOED	The World Bank's Operations Evaluation Department
WIBS	Woreda Integrated Basic Services

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF TABLES IN THE APPENDIX

Appendix Tables **Page**

SOCIO-ECONOMIC IMPACT OF FORAGE DEVELOPMENT ON FARM HOUSEHOLDS LIVELIHOOD IN MIESO DISTRICT, WEST HARARGHE ZONE, OROMIA NATIONAL REGIONAL STATE

BY

IBRAHIM AHMED, B.Sc. HARAMAYA UNIVERSITY, ETHIOPIA

ADVISOR: JEMA HAJI, PHD, HAROMAYA UNIVERSITY, ETHIOPIA

CO-ADVISOR: BERHANU GEBEREMEDHIN, PHD, IRLI, ETHIOPIA

ABSTRACT

Livestock and their products are becoming an important market-oriented commodity in Ethiopia. This study aims at shedding some lights on the ex-post potential socio-economic impact of improved forage development on farm households' livelihood improvement. It does so through an empirical investigation of the impact of forage technology adoption on income, health, education, reduced job burden of women, saving of school time of children and nutritional status of 120 sampled farm households in Mieso district. As technology adoption is randomly assigned, the study used non-parametric 'p-score matching analysis' in assessing the 'causal' effect of the improved forage technology on farm-households' livelihood. This method was checked for covariate balancing test with standard bias, t-ratio and joint-significance level test. Descriptive and econometric methods are used to analyze the data. Of the 120 sampled households, improved forage technology users were 60 and the rest were non-users. Descriptive analyses of t-test and χ^2 test results *shows the existence of significant mean and proportion difference between users and non-users in terms of education, active labor force, land size, fattening experience, livestock ownership, information accesses, participation in demonstration days and accesses to credit which shows the descriptive results improved forage have positive impacts on outcome of the studies income, women work time, children study time, health and education expense at*

1% significant level, while nutrition status at 5% significant level. Also market-oriented livestock product sold Milk, Butter, Cattle, and Shoat affects at 1% level, while Honey and Camel at 5% and 10% percent level. Propensity score matching analysis also show that adoption of improved forage technology have significantly and positively affected by active labor force, information accesses, fattening experience, demonstration day, and livestock holding while age, family size and market distances have a significant negative effect. The sensitivity analysis also shows that the impact result estimates are insensitive to unobserved selection bias. Overall, the adoption of improved forage on socio-economic livelihood have significant positive impact on the households' total income, income from livestock sale, reducing women job burden, saving school time of children and expenditures on health status. The thesis finally discusses these results in detail and draws some recommendations. So it is recommended to scale up and out the adoption of the improved forage technology to other farmers in the district as well to other regions with similar socioeconomic characteristics.

1. INTRODUCTION

1.1. Background and Justification

Increased demand for livestock products in the developing world, as a result of population increase, economic growth and urbanization, present new challenges and opportunities for small-scale livestock farmers, herders and landless people. Meeting a doubling in demand for livestock production and doing so using the same resource base and in environmentally sustainable ways do not include the poor people would be challenging (ILRI, 2009).

The development of the Ethiopian economy heavily depends upon the speed with which agricultural growth is achieved. The rate of the agricultural growth in turn depends on the speed with which the current subsistence oriented production system is transformed into a market-orientated production system. Among many institutional support services that need to catalyze the transformation process, the agricultural extension service plays a critical role, since it contributes to the development of the skill and knowledge of farmers to adopt new technologies (Spielman *et al.*, 2008).

Like most countries in the Sub-Saharan Africa (SSA) agriculture is the mainstay of the Ethiopian economy contributing about 43.5% of the gross domestic product (GDP), 85% of the employment and 61% consistent of the export earnings (MOFED, 2009). Despite, its importance in terms of food production, employment and foreign exchange earnings, but the productivity of smallholder agriculture has remained low.

A livestock production is an integral part of the country's agricultural systems which contributes about 11.5% of the total GDP and 25% of the total agricultural gross domestic product (MOFED, 2009).The different agro-ecological zones the country enjoys, allow the production of various species of livestock. There is no doubt that Ethiopia has by far the largest number of animals of any African country. If CSA (2009), data are taken as the reasonably representative one the country's livestock population is estimated to be 48.3 million cattle, 26.1 million sheep, 21.88 million goats, 6.04 million equines, 22.3 million camels and 38.13 million chickens.

Also, MOFED (2009) estimates that pastoralist's use 60% of the country's land area and of the country own73% goats, 25% sheep, 20% cattle and all of the camels. Annual off-take rate*EB/ head CSA off-take price is estimated at 9% for cattle, 30% for sheep, 31.2% for goats, and 2% for camels. The estimated annual growth rates are 1.2% for cattle 1% for sheep, 0.5% for goats and 1.1% for camels. Livestock have multitude social and economic functions at national level. Cattle together with sheep and goat are the most important sources of live animal, hides and skins for export markets. It also provides employment for a considerable number of the people that are engaged in livestock trade permanently as traders, brokers, and government institutions also, hire many people for management of livestock and livestock products.

Even though livestock is indispensable to smallholder farming, farmers have not obtained expected benefits from the sub-sector due to mainly feed scarcity which in turn contributed to decreased animal productivity. Feed shortage believed to have been caused by a multitude of factors including expansion of crop production, unused bushes, over grazing to traditional communal grazing areas, low adoption of improved livestock feed technologies and practices. In an attempt to address the low and continuously declining livestock feed which has seriously undermined the productivity of the mixed crop-livestock farming system of Mieso district, several approaches were adopted by IPMS project in collaboration with the Mieso Pastoral district office. The project, entitled: "Improving productivity and market success" (IPMS) of Ethiopian farmers, aims at contributing to the reduction in poverty of the rural poor through market- oriented agricultural development.

1.2. Statement of the Problem

Despite the various efforts made to transform smallholder agriculture to produce sufficient food in the country and other public response like food aid programs to protect farm households from impact of income risk, still food insecurity is a chronic problem and about 10 percent of the population of the country requires food aid assistance each year (WB, 2005). Rainfall variability, in addition to limiting the ability and motivation of farmers to invest in agricultural technologies and yield increasing inputs, reduces production, which can decrease both consumption and income of households.

Even though, IPMS of Ethiopian farmers projects participate in the improved forage technology transferred to poor farmers in Mieso district through the different approaches for the last five consecutive years to meet its objectives. But benefit of the intervention or impacts of improved forage on poor household livelihoods in the study area are not analyzed.

Preliminary assessment of these resource-conserving interventions signaled not only increased availability of livestock feed but also has contributed to the rehabilitation of degraded lands there by contributing to the livelihood of smallholder farmers in the project area. Detailed data, however, are not available to substantiate the claims and to scale out the interventions from the project area to similar areas. Without a formal study and hard facts and figures, the technical and economic benefits generated by the interventions may remain unknown. Therefore, an adoption and impact study is required not only to assess the factors that influence the adoption and diffusion of resource conserving forage technologies but also of the impacts of such interventions on the household. Moreover, there were no studies conducted on this issue in the study area. Hence this study aimed at filling this research gap.

1.3. Objectives of the Study

The general objective of the study is to generate an understanding experienced of the socio-economic impacts of improved forage development on farming household livelihood in Mieso district of West Hararghe zone.

The specific objectives of the study are:

- Assess the impact of improved forage development on farm household total income and income from livestock
- Assess the impacts of forage development on social welfare issues (education, health and nutrition status, job burden of women and school time of children).

1.4. Scope and Limitations of the Study

This study aims at analyzing socio-economic impact of forage technology development on households livelihood in Mieso district. As the IPMS of Ethiopian farmers is a multi-

sector project aimed at fighting extreme poverty by providing an integrated package of different commodity to poor families. Of these commodities, due to cost and time constraints the study was limited only on the impact of improved forage development on households' income and other socio-economic factors. The study is constrained by lack of baseline data, by lack of clear and wide range of previous empirical studies of PSM model particularly on socio- economic impact of improved forage development on household livelihood establishing criteria and its clear indicators for its measurements.

1.5. Significance of the Study

In Ethiopia, the analysis socio-economic impact of forage development on farm households livelihood especially in pastoral and agro-pastoral areas are scanty. The study aimed to bridge this research gap. It provides useful information, knowledge and skill to enhance the adoption of improved forage technologies that can guide choices about scaling up and scaling out improved forage in the project district as well as other districts with similar socio-economic settings. It has generated valuable knowledge to inform farmers, donors, implementing agencies, policy makers and researchers for designing appropriate polices for intervening in the development of livestock sub–sectors in the study area and in others similar areas.

1.6. Organization of the Thesis

This thesis is organized into five chapters. The first chapter, being the introductory part, describes background on the socio-economic impact of improved forage development on farm household livelihood, describes the statement of the problem, state the study objectives and its significance. Chapter two provides review of related literature on technology adoption and its impact on the livelihood of the poor. Chapter three outlines the methodology adopted for the study. Chapter four presents results and discussion, while chapter five summarizes the findings of the study and provides conclusion and recommendations.

2. LITERATURE REVIEW

Historically, few issues have attracted the attention of economists as has the role of agriculture in economic development and poverty reduction, generating an enormous literature of both theoretical and empirical studies. Much of these literature focuses on the technology adoption impacts on the farm household generation of income and others social issue change of the poor households livelihood.

2.1. Securing Forage Diversity for Future Livelihoods

Diversity assessment is closely linked to activities in making better use of the diverse forage resources available as part of improved feeding strategies for sustainable livestock production systems. Given the changing nature of livestock systems we can anticipate that the role for forage species will also change. There will be new demands to feed animals to respond to market opportunities, as well as opportunities for both forages *per se* as well as the genes within forage species to address changing ecosystem and mitigate land degradation, often resulting from climate change. To meet such demands, which cannot at present be precisely predicted and to ensure that the diversity contained within many thousands of forage species is not lost, there is a need to conserve, manage and document the diversity of forage (ILRI, 2009).

Environmentally efficient options of intensifying crop-livestock systems builds upon mitigating livestock feed scarcity, where appropriate use of watersheds and irrigated systems for fodder production will help to sharpen more specific feed options which lead to increasing income from livestock. In many developing countries currently providing most livestock future challenges will be to address their role in changing market circumstances, managing environmental goods and services in ways that ensure sustainable production of feed to address livestock productivity and competitiveness, rapidly rising prices of feeds and impacts of climate change (ILRI, 2009).

Although a number of projects were involved in feed and water resources development in both crop-livestock and pastoral systems, the recent ones include the fourth livestock development project, the smallholder dairy development project (SDDP), and the national

livestock development project (NLDP). Activity that was included in the improvements of the natural pastures, feed conservation practices, introduction of improved forages using different strategies were facilitated through these projects used government nurseries for the multiplication. However, the success of these projects adoption of feeds technologies had been determined. Recent trends however, indicate that there is a renewed interest to introduce improved forages for feed production and natural resources management in the various parts of the country. According to Dr. Jean Hanson indicated in their literatures' requests by the regional governments, NGOs and the private sector for forage seeds and cuttings from ILRI's forage germplasm collections has increased over the last five years (Berhanu *et al*., 2006).

In the face of climate change, populations that depend on agricultural systems may have to adjust their production technologies and practices if they are to continue meeting the food and livelihood requirements that they currently derive from these agricultural systems. Adapting to and coping with a changed climate are not infinitely plastic and there are places where climate change may alter agro-ecological conditions beyond what households can deal with. Recent work points to the possibility of climate-induced livelihood transitions in the mixed crop-livestock rain fed arid-semiarid systems of Africa (ILRI, 2009).

2.2. Market-oriented Production

Market-oriented production entails modernization of systems, which depends heavily on the intensification of production processes, adoption of new technology and farm mechanization. As the marketed share of agricultural output increases, input utilization decisions and output combinations are progressively guided by profit maximization objectives. This process leads to the systematic substitution of non-traded inputs with purchased inputs, the gradual decline of integrated farming systems and the emergence of specialized high value farm enterprises (Omit *et al*., 2006).

Commercial orientation of smallholder agriculture leads to a gradual decline in real food prices due to increased competition and lower costs in food marketing and processing as well as potential benefits of higher product prices and lower input prices due to

commercialization are effectively transmitted to poor households when market access is guaranteed (IFAD, 2001).

However, it had become apparent around 1996 that without integrating farmers into the market, sustained growth in the agriculture sector would not be realized. Perhaps as a result, the government policy on the agricultural development made emphasize on the transformation of the subsistence agriculture into market-orientated production system as a basis for the long-term development of the agricultural sector. Such policy emphasis on market-orientation has led to the establishment of the State Ministry of the Agricultural Marketing. This specific emphasis is given to the role of co-operatives for the supply of credit and input or output marketing services. The extension service would have to make proper linkages with the co-operatives and improving the smallholder productivity. Policies and programs designed in the recognition of this potential have succeeded in the many parts of Asia, and have contributed significantly to reducing food insecurity, rural poverty and stimulating agricultural development and wider economic growth (Berhanu *et al.*, 2006).

2.3. Technology Adoption

Several authors defined adoption of technologies in different times. Adoption can be defined as the continued use of recommended idea or practice by individuals over a reasonably long period of time and the adoption is not a permanent behavior (Doss, 2003). An individual may decide to discontinue the use of an innovation for a variety of personal, institutional or social reasons, one of which might be the availability of an idea or practice which is better in satisfying his/her need (Desgupta, 1989). Given the farmer has all the information about the new technology and its potential uses, the adoption of the new technology can be also defined as the degree of use of a new technology in a long-run equilibrium (Feder *et al*., 1985). Adoption is the decision-making process in which an individual asses from first hearing about an innovation to final adoption (Rogers, 1962).
A distinction exists between adoption at the individual farm level and aggregate adoption within a targeted region. Adoption at the farm level reflects the farmer's decision to incorporate a new technology into the production process while aggregate adoption is the process of spread or diffusion of a new technology within a region (Feder *et al*., 1985). At the farm level for investigating the adoption process there should be a complete analytical

frame work that include farmer's decision making model determining the extent and intensity of use of a new technology at each point throughout the adoption process. Aggregate adoption is measured by the aggregate level of use of a specific new technology within a given geographical area or a given population (Rogers, 1962). The rate of adoption is defined as the proportion of farmers who have adopted a new technology over time and the incidence of adoption is the percentage of farmers using a technology at a specific point in time (e.g., the percentage of farmers using fertilizer). The intensity of adoption is the aggregate level of adoption of a given technology (e.g., the number of hectares planted with improved seed) (Feder *et al*., 1985).

The adoption pattern to a technological change in agriculture is not uniform at the farm level and it is a complex process, which is governed by many socio-economic factors. The farmer's socio-psychological system and their degree of readiness and exposure to improved practices and ideas where changes like the awareness and attitudes of farmers towards improved agricultural technologies and institutional factors which act as incentives or disincentives to agricultural practices and the farmers' resource endowment like the land holding size and labor are some of the factors of considerable importance in bringing about the technological change in agriculture (Aregay, 1979).

Adoption of innovations has been modeled using static and dynamic perspectives in adoption studies. In static analysis the behavior of an individual farm household or a group of households is determined at certain point during the adoption process while in the case of dynamic analysis is based on changes in the decision making parameters over time (Doss, 2003).

2.4. Empirical Adoption Studies

2.4.1. Farmers' perception about improved technologies

Farmers' perception about technology is one of the factors, which can facilitate or undermine adoption of improved forage technology and there are different socio-economic and institutional factors hindering individual farmers from using the technology (Yishak, 2005). Different scholars define perception in different ways. Perception is the more

complex process by which people select, organize, and interpret sensory stimulation in to a meaningful and coherent picture of the world (Berelson and Steiner, 1964). Atkinson *et al.* (1985) defined perception as the process by which we organize integrate and recognize patterns of stimuli. Berelson and Steiner (1964) indicated that the importance of perception is apparent from the objective or physical environment, interpreted by the individual, makes up his "behavioral" or "psychological" environment and it is this psychological environment with which we must deal to understand learning or any other form of social or adoption behavior. A number of studies have analyzed the relationship between characteristics of an agricultural technology and its rate of adoption. Most have used more or less objective judges, or have assumed that all farmers perceive these characteristics in the same way. A person's perception of an innovation may, however, differ widely from the actual characteristics of the innovation. Perception is influenced by our values, beliefs and attitudes, and objective assessment of relative advantage, compatibility, etc, is difficult for everyone to act (Adams, 1992; Bekele *et al*., 2000).

According to Adesina and Zinnah (1993), perceptions are subject to change across time and place. An individual's perceptions of an innovation are likely to change after he adopts it. If his/her actual experience with the innovation is satisfactory, his/her perceptions probably will become more favorable. They also indicated that adoption (rejection) of technologies by farmers may reflect rational decision making based upon farmers' perceptions of the appropriateness of the characteristics of the technologies under investigation. When we look at farmer's adoption-perception paradigm it is very difficult to measure perception in retrospect by asking respondents to recall how they perceived an innovation at some previous time, such as before they adopted it.

A study conducted in Eastern Africa was able to identify poor correlation between farmers and breeders evaluations, because the main classical breeding tool-the breeder's index did not seem to represent farmers' preference (De Groote *et al*., 2002). The study employed participatory breeding approach in identifying farmers' preferences for new maize varieties using a numbers of techniques (participatory methods in maize breeding), which included classical on station breeding trials, mother and baby trials, farmer evaluation and participatory rural appraisal.

In their study Dawit *et al*. (2008) found that farmer's choice between the various hybrids

and OPVs of maize related mainly to the availability of seed and their qualities: the popular hybrid varieties are preferred for their wider adaptability, good drought tolerance and high yield. While many farmers were originally discouraged from planting maize hybrids due to the area's susceptibility to drought-related stress, many choose to plant hybrids if the early rains are adequate.

2.4.2. Factors that determine farm household's adoption decision

Several adoption literatures show that adoption of agricultural technologies is influenced by a number of interrelated components within the decision environment in which farmers operate. Factors such as, characteristics of household (education, age and family size), farm characteristics, technology characteristics, wealth (economic status), contact with extension workers, farmers' knowledge of the specific technology, price, access to credit, position of farmers in farmers' organization were important determinants of adoption of innovations stated by different authors of adoption literature. For instance, lack of credit, limited access to information, aversion to risk, inadequate farm size, insufficient human capital, tenure arrangements, absence of adequate farm equipment, chaotic supply of complementary inputs and inappropriate transportation infrastructure were the key constraints to rapid adoption of innovations in less developed countries (Feder *et al*., 1985). However, not all factors are equally important in different areas and for farmers with different socio-economic situations. Many producer technology adoption studies are related to individual farmer choices as influenced by factors that can be categorized into: farm and farmer's characteristics; technology characteristics and farming objectives (Adesina and Zinnah, 1993).

Farmers' decision to adopt or reject new technologies can be influenced by factors related to their objectives and constraints. These factors include farmers' resource endowments as measured by (1) size of family labors, farm size and oxen ownership, (2)farmers' socio–economic circumstance (age, and formal education) and (3) institutional support system available for inputs (CIMMYT, 1993). Farmers also have subjective preference for technology characteristics which could play major role in technology adoption. According to Adesina and Zinnah (1993) farmers' decisions to adopt a new technology in preference to other alternative technologies depend on complex factors. Adoption (rejection) of technologies by farmers may reflect rational decision making based up on farmers'

perceptions of the appropriateness (inappropriateness) of the characteristics of the technology under investigation.

Age and sex of household heads influences the adoption of new improved technologies. Regarding the relationships of age of household head and adoption decisions of new agricultural technologies different empirical studies revealed conflicting results. For instance, a Tobit model result by Bekele *et al.* (2000) indicated that age of the household head negatively affected the mean proportion of land allocated to improved wheat varieties. A similar result by Mahdi (2005) and Yitayal (2004) confirmed that when a farmer's age increases the probability of using improved technology decreases. A reason given by the authors for the negative relationship between age and adoption of improved technologies is an assumed longer planning horizon for younger farmers relative to older ones. On the other hand, age influences positively the adoption of alley farming agro forestry technology in Nigeria (Adesina and Chianu, 2000). The two reasons given for this effect are: First older farmers may have accumulated more knowledge of the benefits of fallow, from their years of experience. Secondly older farmers may find the management of the conventional alley farming system too labor-intensive.

With respect to sex of household heads several past adoption studies revealed that male headed households are more likely to adopt new technologies than their female headed counterparts. Legesse (1992) indicated that the likelihood of adoption is higher among male headed farm households than female headed ones.

Exposure to education is generally supposed to increase a farmer's ability to obtain, process, and use information relevant to the adoption of improved agricultural technologies. A study on adoption of new technologies in Ethiopian agriculture in Tegulet-Bulga district, Shoa province and found that education level of farmers had positive effect on the adoption of new technologies in Ethiopian agriculture (Kebede *et al*., 1990). Asfaw *et al.* (1994) also revealed that education level contributed positively to adoption of fertilizer technology. Whereas, a conflicting empirical result by Harper *et al.* (1993), indicated that education influenced the adoption of the technology negatively. The authors in the later explained that a possible explanation for this behavior is that the higher educated producers perceive a greater return to their management and labor time elsewhere in their operation (Harper *et al*., 1993).

Farm size influences different farming communities differently in their adoption decision process. Tesfaye (2004) has found a significant positive relationship between farm size and adoption of chemical fertilizers indicating that the larger the farms size the greater the probability of adopting chemical fertilizer. Dawit *et al*. (2008) also revealed that the total land operated and owned (two closely correlated variables) showed significant differences between farmers cultivating different types of maize varieties. Those farmers who grew both improved and local varieties showed high levels of land (both owned and operated) compared to those growing only local varieties or only improved varieties. However, the number of parcels operated did not vary significantly among farmers growing different maize varieties.

Livestock holding is also another influential factor that affects the adoption of agricultural technologies stated in different literatures. The result of a study conducted by Tesfaye *et al*. (2001) showed that livestock ownership has a significant positive effect on adoption of high yielding maize technology in major maize growing regions of Ethiopia. Contrary to this result, Wubeneh (2003) showed that livestock holding influenced negatively the farm level adoption of improved sorghum varieties. His explanation for this reason is that livestock are generally considered a symbol of wealth and farmers with large livestock herd sizes tend to focus more on their livestock operations and pay less attention to their crop production. Oxen ownership influences farmers' adoption decision of improved varieties and chemical fertilizers. Yishak (2005) indicated that the number of oxen owned by the household influenced positively the adoption of improved maize varieties. A similar research conducted by Lelissa (1998) in West Shoa Zone, revealed that it affected positively the probability of adoption and intensity of fertilizer use.

A study conducted by Chilot (1996) in Welmera and Addis Alem areas of Ethiopia showed that the adoption of improved wheat seeds is positively and significantly influenced by the wealth status of the farmers, farmers' contacts with extension agents and availability of fertilizer on time. He underlined that the distance to an extension office from a village influences the adoption of improved wheat seed negatively and significantly. He goes on arguing that the higher the incremental net benefit of the improved technology over the traditional practice, the higher the probability and rate of adoption. However, the effect of other factors like area cultivated, literacy, livestock ownership and farmer's years of experience are found to be non- significant. Asfaw *et al*.

(1994) in Bako area reported that participation of farmers in extension activities (which is represented by farmer's attendance at the field days) is the only variable which is found to significantly influence the adoption of improved maize variety. The same study showed that the adoption of fertilizer technology in maize production is influenced positively and significantly by the farmers' use of credit and by the level of formal education of farm household head.

2.5. Impact of Technology Adoption on Livelihood Improvement

Like in every society, individual households in the study area are endowed with infrastructure, natural (land, water, wildlife, etc), human (skills, aptitudes, knowledge, etc.), financial, physical and social capital (savings, networks, trust, etc.) resources which constitute the resource constraint based on which they maximize their well-being. These resources are affected by exogenous factors such as agro-climatic conditions (drought, rain-fall, etc.) animal diseases and lack of feed for their animals which hinder their productivity. Change in technology used through the development of improved forage varieties which have better characteristics (drought tolerance, high yield, etc.) and their dissemination process affect farmers' perception, beliefs expectations and preference towards the technology. This is because, based on the characteristic of the improved forage varieties and demonstrations through field days, farmers believe that adoption of improved forage technology would increase their yield and therefore anticipate high benefit. These constitute the farmers' "value formation" which in turn will condition their decisions in term of investment, livestock and varietals choice, and resource allocation to various inputs. Their decisions have to change because the new technology may need different type of inputs compared to what they were using before. Expectedly, this would affect their consumption, marketing of livestock and their products, savings, and income generation activities. Therefore, household decisions and choice constitute their behavioral outcomes which will finally affect their income and poverty level (welfare outcomes)

2.5.1. Impact of technology adoption on income and consumption

Income or consumption has been traditionally used as measures of material deprivation. Consumption is typically preferred over income as the former better captures long run

welfare. Consumption may also better reflect household's ability to meet their basic needs. Income is one of the factors that enable consumption, though consumption also reflects a household's access to credit and saving at times when their income is too low. Hence, consumption is a better measure of a household's welfare than income. Moreover, in a developing country setting, households are likely to underreport their income level more than they do with their consumption (MoFED, 2002).

Agricultural growth is essential for fostering economic development and feeding growing populations in most less developed countries (Datt and Ravallion, 1996).Yet, since area expansion and irrigation have already become a minimal source of output growth at a world scale, agricultural growth will depend more and more on yield-increasing technological change (Hossain, 1989).

Drawing from existing literature, gains from new agricultural technology have influenced the poor directly, by raising incomes of farm households, and indirectly, by raising employment, wage rates of functionally landless laborers, and by lowering the price of food staples (Hossain *et al*., 1994; De Janvry and Sadoulet, 1992). Implications, as at the household level many other factors may have changed along with technology. This is an important methodological concern if we want to evaluate the impact of new forms of technical change, which are raising questions about the potential adverse or favorable impact on economic conditions of the poor. Economic development, coupled with rising per capita incomes, technological change, and urbanization is causing significant changes in food markets in developing countries (Reardon and Timmer, 2005).

2.5.2. Improved forage impact on women work and student study time

A number of time-budget studies indicate that tasks such as livestock feed collection, water fetching, fuel collection, food processing and preparation can account a part of an adult woman's extremely long working day. Allocating resources to a better sanitation, easy access to water points, cheap sources of fuel, improved means transportation would have immediate beneficial consequences, as would the reduction of laborious food processing operations through the introduction of labor and time saving technologies (UNESCO, 1985).

In view of this, one of the goals in the advancement of women was the introduction of some means by which women would be able to reduce their heavy work load and also raise their incomes and this provision of simple technology applied by UNICEF to be through the WIBS program whose aim is to provide services which are sustainable and replicable through the adoption of low-cost community–managed technologies and by the means of the community empowerment with participation of women reduced women and children work load in the deferent parts of the WIBS Woreda program in the country (UNICEF, 1994a).

2.6. Impact Evaluation

Impact evaluation reflect to the systematic identification of the effects, positive or negative, intended or not on individual households, institutions and the environment caused by a given development activity such as a program or project. Impact evaluation helps us better understand the extent to which activities reach the poor and the magnitude of their effects on people's welfare. Impact evaluations can range from large scale sample surveys in which project populations and control groups are compared before and after and possibly at the several points during the program intervention, to rapid assessment and participatory appraisals estimates of the impact are obtained from combining group interviews, key informants, case studies and secondary data (Mackay *et al.*, 2004).

2.6.1. Defining and approaches to impact assessment

Different definitions have been given to impact assessment by different organizations and scholars. But the commonly used definition of impact assessment as it is given by Omoto (2003) and Rover and Dixon (2007), is that it is a process of systematic and objective identification of the short and long-term effects–positive and negative, direct or indirect effect of intervention on economic, social, institutional and environments. Such effects may be anticipated or unanticipated, and positive or negative, at the level of the individual, household or the organization caused by on-going or completed development activities such as a project or program.

According to FAO (2000), impact assessment is done for several practical reasons: (1) accountability – to evaluate how well we have done in the past, to report to stakeholders

on the return to their investment, and to underpin political support for continued investment; (2) improving project design and implementation-to learn lessons from past that can be applied in improving efficiency of research projects; and (3) planning and prioritizing - to assess likely future impacts of institutional actions and investment of resources, with results being used in resource allocation and prioritizing future projects and activities, and designing policies.

Since non experimental methods use statistical techniques to model the behavior of participating and non-participating households, using requires a high level of precaution to avoid or minimize estimation biases. The first kind of estimation bias arises from failing to account for observable variables, called *omitted variables* estimation bias (Rubin, 1974). The second kind of estimation bias is called *selection bias* and comes from endogenous program placement. Assignment of poverty reduction programs often is determined by selection criteria (Rubin, 1974).

An impact evaluation assesses the extent to which a project has caused desired or undesired change on the intended users. It is concerned with the net impact of an intervention on individuals households or institutions, attributable only and exclusively to that interventions (Baker, 2000). Thus, impact evaluation consists of assessing outcomes of research and developmental changes resulting from interventions.

Based on the time continuum, there are two types of impact assessment studies. *Ex ante* type is about assessing the impact of the likely future environments and of expected impacts from the interventions. It is applied to assist in decisions on approval and funding of any project, whereas *ex-post* evaluates performance, achievements and impacts of the past activities of the project (FAO, 2000). The resulting information is used in accounting for the past use of resources, and as a useful input for future planning.

2.6.2. Types of impact assessment

According to Ponniah *et al.* (1996), comprehensive impact evaluation can be undertaken at two levels viz. people (household) and community.

2.6.2.1. People level impact

People level impact refers to the effect of the intervention on the ultimate users or target group for which the technology is developed and adopted. Impact begins to occur when there is a behavioral change among the potential users. The people level impact deals with the actual adoption of the appropriate technologies and subsequent effects on production, income, environment and/or whatever the development objective may be (Omoto, 2003).

2.6.2.2. Community level impact assessment

According, North (1996), institutions are rules of game and organizations and their entrepreneurs are players. Increasing agricultural productivity, whilst strengthening local institutions, has long been an important goal of agricultural research and development. Organizations play an important role in meeting this goal by improving technologies and knowledge base of the biological, social, economic and political factors that govern the performance of an agricultural system, and by strengthening local institutions' capacity and performance. Most impact evaluation studies are often subjected to rigorous appraisals from economic and environmental perspectives, without giving due attention to the institutional aspect of the interventions (Ponniah *et al.*, 1996).

Economic impact assessment

Economic impact measures the combined production and income effects associated with a set of research and development activities (Ponniah and Martella, 1999). The economic impact assessment studies range in scope and depth of evaluation from partial impact studies (adoption studies) to comprehensive assessment of economic impacts (FAO, 2000). One popular type of partial impact assessment is adoption studies that look at the effects of new technologies such as the spread of modern crop varieties on farm productivity and farmers' welfare. Economic impact assessments of the more comprehensive types look beyond mere yield and crop intensities to the wider economic effects of the adoption of new technology.

Social impact assessment

Social impacts are important and need to be considered along with the economic and environmental impacts. Social impacts assessment include the effects of intervention of the project on the attitude, beliefs, resource distribution, status of women, income distribution, nutritional implications, institutional implications etc of the community. These have been assessed through socio-economic surveys and careful monitoring. Social impact has the potential to contribute greatly to the planning process of other types of development projects (FAO, 2000).

2.6.3. Ways of establishing controls in impact evaluation

There are different ways of establishing controls for impact evaluation such as randomized controls, constructed controls and reflexive controls are the most commonly used.

Randomized controls: Individuals are randomly placed into two groups in which the selection into the treatment and control groups is random within some well-defined set of people. Subjects are randomly assigned to project and control groups. Questionnaires or other data collection instruments are applied to both groups before and after the project intervention. In this case there should be no difference (in expectation) between the two groups besides the fact that the treatment group had access to the program. (There can still be differences due to sampling error; the larger the size of the treatment and control samples the less the error.

Constructed controls: Individuals to whom the intervention is applied are matched with an "equivalent" group from whom the intervention is withheld. Matching methods or constructed controls, in which one tries to pick an ideal comparison that matches the treatment group from a larger survey. The most widely used type of matching is propensity score matching, in which the comparison group is matched to the treatment group on the basis of a set of observed characteristics or by using the propensity score (predicted probability of participation given observed characteristics); the closer the propensity score, the better the match. A good comparison group comes from the same economic environment and was administered the same questionnaire by similarly trained

interviewers as the treatment group.

Reflexive controls: Participants who receive the intervention are compared to themselves before and after receiving the intervention. That in which a baseline survey of participants is done before the intervention and a follow-up survey is done after. The baseline provides the comparison group, and impact is measured by the change in outcome indicators before and after the intervention (Rossi and Freeman, 1982).

2.6.4. Impact evaluation designs

Experimental designs: Also known as randomization, are generally considered as the most robust of the evaluation methodologies (Baker, 2000). By randomly allocating the intervention among eligible beneficiaries, the assignment process itself creates comparable treatments and control groups that are statistically equivalent to one another, given appropriate sample sizes. In a randomized experiment, the treatment and control samples are randomly drawn from the same population. In other words, in a randomized experiment, individuals are randomly placed into two groups, namely, those that receive treatment and those that do not. In this case observable and unobservable characteristics get uncorrelated thus no selection bias problem arises. This allows the researcher to determine project impact by comparing means of outcome variable for the two groups which yields an unbiased estimate of impact (Nssah, 2006).

Although experimental designs are considered the optimum approach to estimate project or program impact, in practice, there are several problems. It is not feasible in demand driven programs in which participants make their own decisions of whether to participate and about the kind of activities to do in the learning process (Ravillion, 2005; Baker, 2000), also argues that individuals in control groups may change certain identifying characteristics during the experiment that could invalidate or contaminate the results. Moreover, experimental designs can be expensive and time consuming in certain situations, particularly in the collection of new or raw data.

A quasi-experimental method: It is the only alternative when neither a baseline survey nor randomizations are feasible options (Jalan and Ravallion, 2003). The main benefit of quasi experimental designs are that they can draw on existing data sources and are thus often quicker and cheaper to implement, and they can be performed after a project has

been implemented, given sufficient existing data. The principal disadvantages of quasi-experimental techniques are that (a) the reliability of the results is often reduced as the methodology is less robust statistically; (b) the methods can be statistically complex and data demanding; and (c) there is a problem of selection bias. When these techniques are used, the treatment and comparison groups are usually selected after the intervention by using nonrandom methods. In some cases a comparison group is also chosen before treatment, though the selection is not randomized. Therefore, statistical controls must be applied to address differences between the treatment and comparison groups and sophisticated matching techniques must be used to construct a comparison group that is as similar as possible to the treatment group (Gilligan *et al.,* 2008).

Double difference or difference-in-differences (DID): This is method in which one compares a treatment and comparison group (first difference) before and after a project (second difference). Comparators should be dropped when propensity scores are used and if they have scores outside the range observed for the treatment group. In this case potential participants are identified and data are collected from them. However, only a random sub-sample of these individuals is actually allowed to participate in the project. The identified participants who do not actually participate in the project form the counterfactual (Jalan and Ravallion, 1999; Baker, 2000).

Ex-post comparison of project group: Data are collected on project beneficiaries and a non-equivalent control group is selected as for data are only collected after the project has been implemented. Multivariate analysis is often used to statistically control for differences in the attributes of the two groups. Assessing the impacts of micro-information constraints can be formidable in conducting impact evaluation that data sources can consist of longitudinal, cross-section, baseline with follow-up, and time series, any of these types of data can be collected using quantitative or qualitative methods.

Rapid assessment ex-post impact evaluations: Some evaluations only study groups affected by the project while others include matched control groups. Participatory methods can be used to allow groups to identify changes resulting from the project, who has benefited and who has not and what were the project's strengths and weaknesses. Triangulation is used to compare the group information with the opinions of key informants and information available from secondary sources (Mackay *et al.,* 2004).

Assessing community managed water supply projects in Indonesia were assessed through this rapid assessment ex-post impact evaluation.

2.6.5. Approaches to impact assessment study

If technology is randomly assigned to households, we evaluate causal effect of technology adoption on households' wellbeing as difference in average wellbeing between adopters and non-adopters of new technology. We can refer to a reduced form model household income equation and technology adoption by the standard separable condition between consumption and production does not hold and production decisions are influenced by the same household characteristics that influence income earning. Does improved technology adoption increase household income? This is the question we seek an answer. Differently said, what we are interested in is not only the correlation *per se* between technology adoption and household income, but also what it reveals about underlying causation (lchino, 2001).

Based on economic arguments, if we argued OLS estimates are biased due to selection on unobservable, we treat the technology variable as endogenous and use instrumental variables (IV). Basic requirements of using IV are set of valid instruments, Z, must be relevant and exogenous (i.e. Cov (Z, T) $\neq$ 0 but Cov (Z, E) = 0). It has the advantage to generate a ''natural experiment'' but we assume un-testable condition exclusion restriction that the IV is independent of outcomes, given observable controls. Both OLS and IV estimation procedures impose a linear functional form assumption, which is arbitrarily ad hoc in that coefficients on control variables are restricted to be the same for adopters and non-adopters (Jalan and Ravallion, 2003). On the other hand, a parametric solution that allows a full set of interaction effects via the Heckman's selection correction model, within an 'endogenous switching regime model', come at the cost of imposing strong distributional assumptions (Main and Reilly, 1993).

Even if the instrumental variables method does not necessarily eliminate the problem associated with placement endogeneity. Moreover, panel data sets are rarely available. Biases also arise when projects are targeted according to individual or geographic variables which influence subsequent growth rates of the outcome indicator (Jalan *et al*.,

1997). Hence, we deal with alternative non-parametric methods to remove some restrictive assumptions. The ‘p-score matching procedure’ Assuming that technology adoption is a function of a wide range of observable characteristics at household level and removing the assumption of ‘‘constant technology effect’’ allow us to follow the PSM procedure. The latter balances distributions of observed covariate between a treatment group and a control group based on similarity of their predicted probabilities of adopting a superior technology (their ‘p-score’). The matching approach is consistent with the theoretical argument that there are many a priori reasons to expect that the effect of technology adoption on income is the result of an interaction with many other variables. Furthermore, the assumption of selection on observable’ is no more restrictive than assuming away problems of ‘weak instruments’ even more with a cross-sectional data set (Jalan and Ravallion, 2003).

Even though matching estimator is quite popular among analysts, some recent empirical literature have identifies potential sources of bias (Heckman and Navarro-Lozano, 2004). The latter are associated with (a) the selection on unobservable; (b) the failure of the common support condition; (c) the importance of considering a rich set of variables related to treatment and outcome; (d) the failure to control for local differences when matching treated and control groups (geographic mismatch) and (e) the importance of measuring the dependent variable in the same way in the treatment and comparison groups (see Smith and Todd, 2003). Whilst the conditional independence assumption rules out potential unobserved explanatory characteristics in the propensity scores estimation.

Impact assessment is often difficult because causality is difficult to determine, in addition to being costly and time-consuming. However, managers need to know the effects of project activities on the intended beneficiaries during implementation and use results to modify project activities. This allows managers to adjust strategies if necessary during implementation, rather than continue less than effective activities (CF/EXD- IC, 1986).

There are many important theoretical reasons why agricultural technology might improve farm household wellbeing, but how can we be sure better wellbeing of adopters compared to non-adopters is caused by technology adoption or not? Ideally, experimental data would provide us with information on the counterfactual situation solve the problem of causal inference (Costa Dias, 2000).

2.7. Empirical Studies on Impact Evaluation

A number of researchers have applied this semi parametric model to evaluate social programs both in Ethiopia and elsewhere in the world. Below are reviews of some of the recent studies who have applied PSM in program evaluations in Ethiopia and else where

Yebeltal (2008) applied the PSM to assess the impact of Integrated Food Security Program in Ibant district of Amhara region. The study found that the program has increased participating households' calorie intake by 30% (i.e., 698 calories) compared to the non-participating households.

In assessing the impact of the Productive Safety Net Program (PSNP) in Ethiopia on livestock and tree holdings of rural households, Andersson *et al.* (2009), have applied PSM model. They found that there was no indication that participation in PSNP leads households to disinvest in livestock or trees. In fact, the number of trees increased for households that participated in the program. It could be the case that participation in the PSNP, leads to households becoming more skilled in forestry, and that they switch to increased forest planting as a result.

In analyzing the impact of social protection on food security and coping mechanisms in Ethiopia's productive safety nets program, Gilligan *et al.* (2008), used PSM method and they found that participation in the public works component of the PSNP (defined as receipt of at least 100 Birr) in payments over the first five months has modest effects. It improves food security by 0.40 months and increases growth in livestock holdings by 0.28 Tropical Livestock Units (TLU). It leads to an increase of 4.4% in the likelihood that a household is forced to make a distress asset sale.

Even though there is a lot of research works conducted on impact assessments of program intervention in different areas, there is no single study regarding the impact of improved forage development for market-oriented livestock production in the country, particularly in the mixed agro-pastoral production system area. This study used PSM method to evaluate the socio-economic impact of improved forage development for market-oriented livestock production in Mieso district.

3. METHODOLOGY

3.1. Program Description

The International Livestock Research Institute (ILRI) and the Ministry of Agriculture and Rural Development (MoARD) initiated a five years project in June 2004 with the financial assistance from the Canadian International Development Agency (CIDA). The project, entitled: "Improving productivity and market success" (IPMS) of Ethiopian farmers, aims at contributing to a reduction in poverty of the rural poor through market-oriented agricultural development. The IPMS of Ethiopian farmers project assist by bringing knowledge on technologies generated by international and national research institutes as well as from other sources to the attention of the technology transfer agents and the farming community. It also facilitates the feedback on these technologies. Such assistance had been provided to 10 pilot learning sites (PLS) across the country, Mieso district is one. To further enhance the utilization of such knowledge and the introduction of technologies, the IPMS project also provide assistance to extension, input supply, marketing innovation and finance institutions, including cooperatives. Such institutional supports were in the form of technical assistance, capacity building, supply of demonstration and training materials, some limited funds for innovative institutional arrangements and studies aimed at developing innovative institutional arrangements (MPLSDPD, 2007).

3.2. Description of Study Area

Mieso district is one of the fourteen districts of West Hararghe Zone, Oromia National Regional State and the livelihood of most of the households depends on livestock-crop mixed production system as well pastoralism.

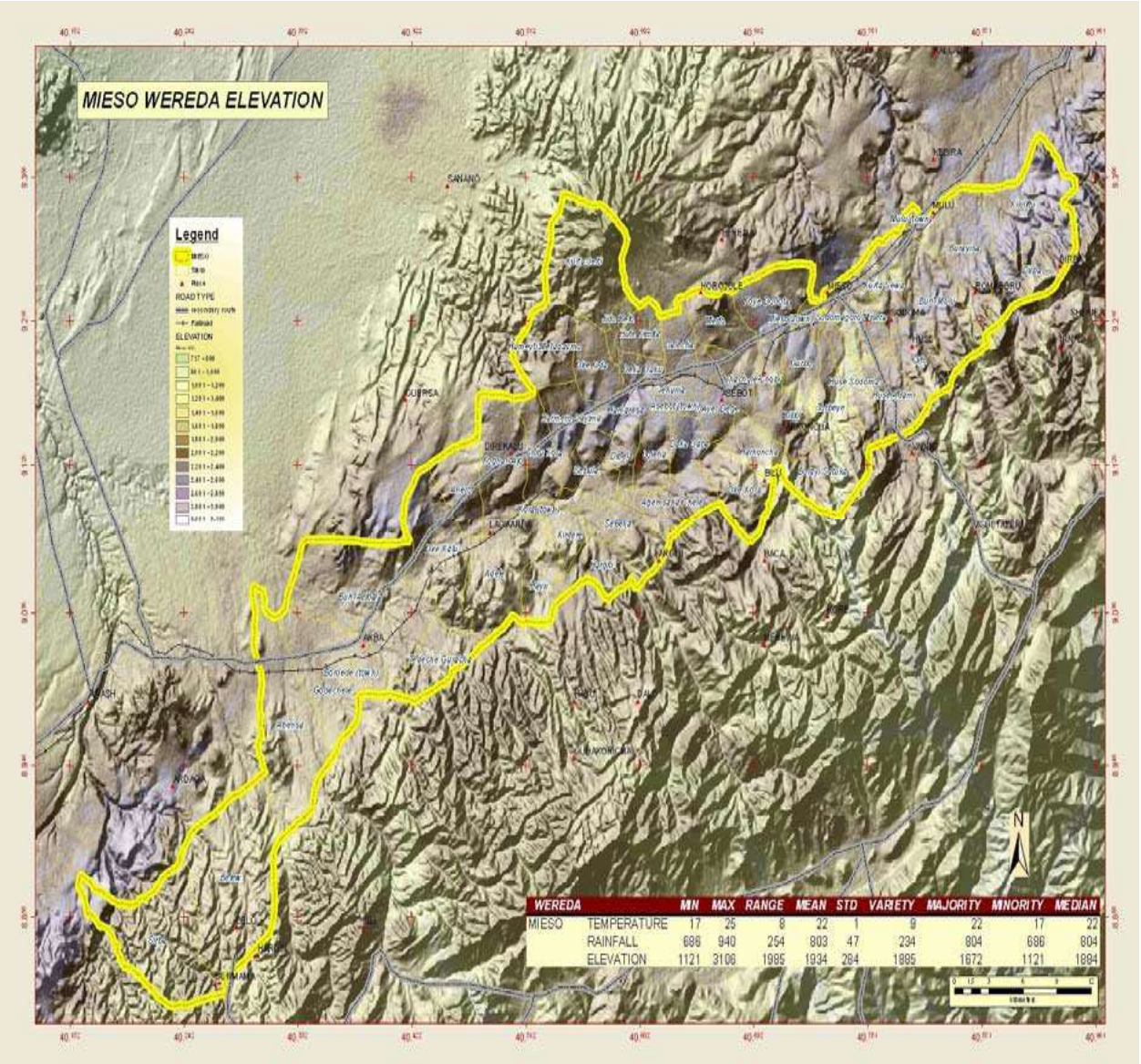
The district is located at 300 km east of A.A, about 27 km north of the zone capital city Chiro, bounded east by Doba in the north, by Chiro and Guba Koricha, in northeast by Anchar woredo and in the northwest, by Somali and South and Southwest by Afar regions.

According to MPLSDPD (2007) the total number of PAs in the Woreda are 46 of which 11 are pure pastoral with the 4784 households, six agro-pastorals kebeles with 3156

households and 29 kebeles with crop-livestock production system having 16243 households of total 24183 household head composed population of 154,581. The district has a total land area of 267344 km^2 of which 22,485 ha are under cultivated, 88645 ha is grazing range land, 67,535 ha is bush forest, 10,000 ha is considered for investment and 7371 ha is used for construction. The livestock population in the district is estimated to be: cattle 112,081, goat 54,914, sheep 32,665, camel 32,019, donkey 9271, poultry 53,553 and beehives 3868.

Geographically, it is located between $40^0 9' 30.1'' W$ and $40^0 56' 44'' E$; and $9^0 19' 52'' N$; and $8^0 48' 12'' N$. The altitude of the district ranges from 1107 to 3106 meters above sea level (masl), but most part of the district is found at about 1700 masl and surrounded by a chain of mountains in nearly all directions. The highest mountain is Asebot, which is located north west of Mieso town. Based on the digital data, mean annual temperature is around $21^0 C$ while average annual rainfall is between 635 - 945 mm. The amount of rainfall seems relatively sufficient if appropriate crops and livestock species are selected. However, the major problem lies in its distribution. Most of the rainfall is received in only few months, where most of the months are dry, as a result recurrent drought is a major problem and is making relief aid a regular source of livelihood for many rural families (MPLSDPD, 2007).

According to FAO/UNESCO soil classification system, the major soils of the woreda are Vertic Cambisoil (Orthic and Ferralic), Haplic Luvisol (Orthic) and Eutric Cambisol (Orthic), accounting for 50%, 16% and 11%, respectively. However, the soil classification was based on 1:2 million scales which may not give a right picture on the ground. Farmers believe that the soils are reasonably fertile, but the major problem which makes the soils to yield low is shortage of rainfall. Otherwise, farmers believe that what they get during good rains is a reasonably ok. Use of commercial fertilizer is not common in the area. Annual fertilizer use in the Woreda is extremely low (MPLSDPD, 2007)



Source: (MPLSDPD, 2007)

Fiuger 1. Mieso woreda Map

3.3. Data Sources, Collection Methods and Sampling Procedure

The analysis of factors influencing adoption of improved forage practices and its impacts on household wellbeing shall mainly be based on quantitative data collected using a structured questionnaire from a randomly drawn farm household heads. A range of data at various scales: district, peasant association and household levels had been collected. Socio-economic, demographic and institutional variables such as farm size, age,

education, access to extension and credit, livestock owned, etc. were collected. Identifying alternative criteria from other data sources, and simulating models that could improve targeting with alternative criteria to meet the study objective of the IPMS of Ethiopian farmers project for impact evaluation, the same system was followed, with the result that localities were randomly allocated to treatment and non-treatment groups. In this study, both primary and secondary sources were used. Primary data were collected from a randomly selected120 farms households through an interview in the Marche 2010 to April 2010. To supplement this information, PRA tools including key informant interviews and focus group discussions had also been utilized. Secondary data were collected from various sources including IPMS, Woreda Pastoral Development Office (WPDO) and other sectors in the district.

A three stage sampling technique was used to select 120 sample households. During the initial stage of the sampling out of 46 PAs in Mieso district 16 PAs were purposively selected since they are the implementation areas of IPMS Ethiopian farmer's projects improved forage practices in Mieso PLS. In the second stage out of the 16 PAs, six PAs were randomly selected. These are Tokuma, Hunde-Misoma, Bililo, Gorbo, Husee-mandhera and Torbayo. In the third stage, depending on the PAs population with diffusion of improved forage per-PA 120 households were randomly selected based on probability proportional to size. The total number of households, users and non-users and the samples selected from these PAs are shown in Table 1.

Table 1. Number of households and sample size

Name PA	Number of households			Sampled households		
	Users	Non-users	Total	Users	Non-users	Total
Tokuma	250	350	600	14	11	25
Hunde-misoma	300	550	850	16	17	33
Bililo	150	200	350	8	7	15
Gorbo	200	200	400	10	6	16
Huse-mandhera	100	300	400	6	9	15
Torbayo	100	320	420	6	10	16
Total	1100	1920	3020	60	60	120

Source: Survey result of 2010

3.4. Data Analysis

The main objectives of the study were to assess the socio-economic impact of improved forage technology on the farm households' livelihood through increasing livestock output productivity. The overall goal of the study was to promote analysis socio-economic impact of improved forage development on farm households' livelihood, through qualitative, descriptive and econometric analysis.

3.4.1. Qualitative data analysis

Information on changes in organizational and institutional aspect of improved forage technology socio-economic impact of improved forage development on farm households' livelihood, were collected from the community using focus group discussion, interviewing experts in different organizations in the district and reference made to secondary sources which were described and explained qualitatively as well as physical observation of the researcher. These information where also used to augment the quantitative analysis results.

3.4.2. Descriptive analysis

Socio-economic impact of improved forage development on farm households' livelihood, on economic and social issue of the households' wellbeing analyzed from the survey of Marche to April 2010 individual households data. The descriptive analysis used tools such as minimum, maximum, mean, percentage, standard deviation, frequency distribution and t- Test and chi-square statistics to compare users and non- users households.

3.4.3. PSM measuring the impact of improved forage adoption

Propensity score matching is a method that improves on the ability of the regression to generate accurate causal estimates by the virtue of its non-parametric approach to the balancing of covariates between the "treatment" and "control" group, which removes bias due to observable variables. The conventional approaches to assessing the impact of an intervention on using with and without method, has essentially been hampered by a problem of missing data. Due to this problem, the impact of intervention cannot be accurately estimated by simply comparing the outcome of the treatment groups with the

outcomes of control groups (Heckman *et al.,* 1998). One of the alternative techniques followed in recent literature to assess the impact of discrete treatment on an outcome is the method of propensity score matches developed by Rosenbaum and Rubin in 1983. In recent times, matching econometric estimators is becoming increasingly popular among economists as the methods to measure impacts of program (Smith and Todd, 2005; Ravallen, 2004; Dehejia and Wahba, 2002; Heckman *et al.,* 1998). The propensity score matching approach aims to build matched pairs of comparable users from the program participants and non-participants that show a similarity in terms of their observable characteristics. This is achieved by grouping households from treated individuals and non-treated individuals simply which shows a high similarity in their explanatory variables. Thus, to support the result obtained from regression analysis the impact of improved forage technology and outcome scheme are examined using econometric PSM method.

3.4.4. Empirical model specification

In this study households who participated in the program of improved forage technology were considered as the treatment group and households who did not participated in the program are considered as control group. These, groups are a comparison group used to evaluate the impact of improved forage technology for market-oriented livestock production on treated groups livelihood. Ideally, the aim is to compare the level of economic and social factors (health, education, and nutrition, job burden of women and school time of children) of improved forage program users to that of non-users. This ensures that the average treatment effect or effect of improved forage adoption for market-oriented livestock production on livelihood could be accurately estimated. Let Y_i^{T} and Y_i^{C} be the amount of income for participants and non-participants respectively. The difference in outcome between treated and control groups can be seen from the following mathematical equation:

$$\partial_i = Y_i^{\mathrm{T}} - Y_i^{c} \qquad (1)$$

Y_i^{T} = outcome of treatment (income of i^{th} household, when he/she uses improved forage), Y_i^{C} = outcome of the untreated individuals (income of i^{th} household when he/she does not involve in improved forage program), ∂_i = Change in outcome as a result of treatment or change of income for participating in the program.

Let the above equation be expressed in causal effect notational form, by assigning $D_i = 1$ as a treatment variable taking the value 1 if individual received the treatment (improved forage technology) and 0 otherwise. Then the Average Treatment Effect of an individual i can be written as:

$$ATE = \mathrm{E}\left(\mathrm{Y}_i^T \mid D = 1\right) - \mathrm{E}\left(\mathrm{Y}_i^C \mid D = 0\right) \quad (2)$$

Where ATE, Average Treatment Effect, which is the effect of treatment on income; $\mathrm{E}\left(Y_i^{\mathrm{T}} \mid D_i = 1\right)$: Average outcomes for individual, with treatment, if he/she would use improved forage technology ($D_i = 1$) . $\mathrm{E}\left(\mathrm{Y}_i^c \mid D_i = 0\right)$: Average outcome of untreated, when he/she were non-uses, $\left(D_i = 0\right)$

To measure the Average Effect of Treatment on the Treated (ATT) for the sample can be reformulated as:

$$\mathrm{ATT} = \mathrm{E}\left(\mathrm{Y}_i^{\mathrm{T}} - \mathrm{Y}_i^C \mid D = 1\right) = \mathrm{E}\left(\mathrm{Y}_i^{\mathrm{T}} \mid D = 1\right) - \mathrm{E}\left(\mathrm{Y}_i^C \mid D = 1\right) \quad (3)$$

The fundamental evaluation problem in estimation of impact is that it is impossible to observe a person's outcome for with and without treatment at the same time. While the post-intervention, the outcome $\mathrm{E}\left(\mathrm{Y}_i^{\mathrm{T}} \mid D = 1\right)$ is possible to observe. However, the counterfactual outcome i^{th} household when she/he does not use the treatment is not observable in the data. Thus, estimation of ATE can give a seriously biased result, due to the fact that the population can be different from the comparison group, not only in terms of treatment status, but also can differ even in terms of other characteristics. This problem is often referred to as the "fundamental problem of causal inference''. Thus, simple mean comparison between the treated and non-treated can be misleading. Yet, taking the mean outcome of non participants as an approximation is not advisable, since participants and non participants usually differ even in the absence of treatment (Holland, 1986; Macro and Sabine, 2008). A solution to this problem is to construct the unobserved outcome which is called the counterfactual outcome that individuals would have experienced, on average, had they not participated (Rosenbaum and Rubin, 1983), and this is the central idea of

matching. According to Rosenbaum and Rubin (1983), the effectiveness of matching estimators as a feasible estimator for impact evaluation depends on the two fundamental assumptions:

Assumption 1: Conditional Independence Assumption (CIA)

In matching the fundamental assumption, Conditional Independence Assumption (CIA), states that treatment assignment (Di) conditional on the attributes) and the coverlet (X is independent of the post-program outcome $\left(Y_i^T, Y_i^C\right)$ in our case, treatment (adoption of improved forage for market-oriented livestock production), potential outcome (total household income (nutritional status, health expenses, education expenses, job burden of women and school time of children) are independent of treatment assignment or independent of how adoption of improved forage for market-oriented livestock production decision is made by the household. In formal notation, this assumption corresponds to:

$$(Y_i^T, Y_i^C) \perp D \mid X_i) \tag{4}$$

This assumption imposes a restriction that choosing to participate in a program is purely random for similar individuals. As a consequence, this assumption excludes the familiar dependence between outcomes and participation that lead to a self selection problem (Heckman *et al*., 1998). The conditional average effect of treatment on the treated has a problem, if the number of the set of conditioning variables (X's) is high, and thus the degree of complexity for finding identical households both from program users and control groups becomes difficult. To reduce the dimensionality problem in computing the conditional expectation, Rosenbaum and Rubin (1983) showed that instead of matching on the base of X's one can equivalently match treated and comparison units on the basis of the "propensity score" defined as the conditional probability of receiving the treatment given the values of X, notational expressed as:

$$P(Xi) = Pr\ (Di = 1 \mid Xi) \tag{5}$$

Where, Pr is the probability, the logistic cumulative distribution 1 = D if the subject was treated and 0 otherwise, Xi is a vector of pre-treatment characteristics. Therefore, this study would use propensity score matching to predict program participation in improved forage development program and a logit model will used to estimate the propensity score P(X). In estimating the propensity scores all variables that simultaneously affect participation in the improved forage development for market-oriented livestock production

and impact on the household economic and social issues will be included. Thus, the average treatment effect on those treated conditional to propensity score P(X) can then be written as:

$$ATT = \mathrm{E}\left(\mathrm{Y}_i^{\mathrm{T}} \mid \mathrm{P}(\mathrm{X}), D=1\right) = \mathrm{E}\left(\mathrm{Y}_i^{C} \mid \mathrm{P}(\mathrm{X}), D=1\right) \quad (6)$$

Assumption 2: Assumption of common support

The common support is the region where the balancing score has positive density for both treatment and comparison units. This assumption rules out perfect predictability of D given X that is:

$$0 < \Pr(D=1|X) < 1 \quad (7)$$

The assumption that P(x) lies between 0 and 1: this restriction implies that the test of the balancing propensity is performed only on the observations whose propensity score belongs to the common support region of the propensity score of treated and control groups (Becker and Lchino, 2002). Individuals that fall outside the common support region would be excluded in the treatment effect estimation. This is an important condition to guarantee improving the quality of the matching used to estimate the ATT. Moreover, implementing the common support condition ensures that person with the same X‘s values have a positive probability of being both participant and non-participants (Heckman *et al*., 1999). This implies that a match may not be found for every individual sample. Rosenbaum and Rubin (1983) describe assumption one and two together as strong ignore ability.

Given the above assumption the PSM estimator of ATT can be written as:

$$T_{\mathrm{ATT}} = \mathrm{E}\left(\mathrm{Y}_1 - \mathrm{Y}_0 \mid D=0, p(X)\right) = \mathrm{E}\left(Y_1 \mid D=1, p(X)\right) - \mathrm{E}\left(Y_0 \mid D=0, p(X)\right) \quad (8)$$

Where p(x) is the propensity score computed on the covariates X. Equation (6) is explained as: the PSM estimator is the mean difference in outcomes over the common support, appropriately weighted by the propensity score distribution of participants.

According to Caliendo and Kopeinig (2008), there are steps in implementing PSM. These are estimation of the propensity scores using binary model, choosing a matching algorism, checking on common support condition, testing the matching quality.

3.4.4.1. Specification of the Logit model

Here a question may arise, why Logit model? A logit regression of treatment status (1 if a household is used improved forage, 0 if household non-users) was run for the sampled households, on observables that include age, education, family size, active labor force, land cultivated, experience in fattening livestock, access to market center, access to information, attending demonstration days, extension visits, livestock holding and access to rural credit services. The major concern of this regression was to predict the probability of a household to be participated in improved forage used for market-oriented livestock production i.e. to predict propensity scores, based on which, the treatment and control groups of households were matched using the matching algorithms**.**

Following Guajarati (1995) the functional form of logit model is specified as follows:

$$P_i = E(\mathrm{Y} = 1/\mathrm{X}_i) = \frac{1}{1+e^{-(\beta_0+\beta_i \mathrm{X}_i)}} \tag{9}$$

For ease of expositions, we write (9) as:

$$P_i = \frac{1}{1+e^{-z_i}} \tag{10}$$

The probability that a given household participated in improved forage users are expressed by (10) while, the probability for non-users of improved forage is given by:

$$1-P_i = \frac{1}{1+e^{z_i}} \tag{11}$$

Therefore we can write:

$$\frac{P_i}{1-P_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} \tag{12}$$

Now $(P_i/1-P_i)$ is simply the odds ratio in favor of being user of improved forage development for market-oriented livestock production. i.e The ratio of the probability of using improved forage to that of the probability of not using it.

Finally, taking the natural logarithms of equation (12) we obtained:

$$L_i = \ln\left(\frac{p_i}{1-p_i}\right) = \mathrm{Z}_i = \beta_0 + \beta_1 \mathrm{X}_1 + \beta_2 \mathrm{X}_2 + - - - + \beta_n \mathrm{X}_n \tag{13}$$

Where P_i is probability of using improved forage that ranges from 0 to 1 and Z_i is a function of n explanatory variables (X_i) which is expressed as:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + - - - + \beta_n X_n \quad (14)$$

Where β_0 is intercept, $\beta_1, \beta_2 - —, \beta_n$ are the slope parameters in the model

L_i = is the log of the odds ratio, which is not only linear in X but also linear in parameters.

X_i is vector of the relevant sampled household's characteristics.

If the disturbances term (U_i) is introduced to the logit model it becomes:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + - - - + \beta_n X_n + U_i \quad (15)$$

3.4.4.2. Choice of matching algorithm

Estimation of the propensity score *per se* is not enough to estimate the ATT of interest. This is due to the fact that propensity score is a continuous variable and the probability of observing two units with exactly the same propensity score is, in principle, zero. Various matching algorithms have been proposed in the literature to overcome this problem. The methods differ from each other with respect to the way they select the control units that are matched to the treated, and with respect to the weights they attribute to the selected controls when estimating the counterfactual outcome of the treated. However, they all provide consistent estimates of the ATT under the CIA and the overlap condition (Caliendo and Kopeinig, 2008). Below, only the most commonly applied matching estimators are described.

(NN) matching: It is the most straightforward matching estimator. An individual from a comparison group is chosen as a matching partner for a treated individual that is closest in terms of propensity score (Caliendo and Kopeinig, 2008). NN matching can be done with or without replacement options. In the case of the NN matching with replacement, a comparison individual can be matched to more than one treatment individuals, which would result in increased quality of matches and decreased precision of estimates. In the case of NN matching without replacement, a comparison individual can be used only once. Matching without replacement increases bias but it could improve the precision of the estimates. In cases where the treatment and comparison units are very different, finding a

satisfactory match by matching without replacement can be very problematic (Dehejia and Wahba, 2002).

Caliper matching: The above discussion tells that NN matching faces the risk of bad matches, if the closest neighbor is far away. To overcome this problem researcher's use the second alternative matching algorism called caliper matching. Caliper matching means that an individual from the comparison group is chosen as a matching partner for a treated individual that lies within a given caliper (propensity score range) and is closest in terms of propensity score (Caliendo and Kopeinig, 2008). If the dimension of the neighborhood is set to be very small, it is possible that some treated units are not matched because the neighborhood does not contain a control unit. One problem in caliper matching is that it is difficult to know a priori what choice for the tolerance level is reasonable.

Kernel matching: This is another matching method whereby all treated units are matched with a weighted average of all controls with weights which are inversely proportional to the distance between the propensity scores of treated and controls (Becker and Ichino, 2002). Kernel weights the contribution of each comparison group member, so that more importance is attached to those comparators providing a better match. The difference from caliper matching, however, is that those who are included are weighted according to their proximity with respect to the propensity score. The most common approach is to use the normal distribution (with a mean of zero) as a kernel, where the weight attached to a particular comparator is proportional to the frequency of the distribution for the difference in scores observed (Bryson *et al*., 2002).

According to Caliendo and Kopeinig (2008), a drawback of this method is that possibly bad matches are used as the estimator includes comparator observations for all treatment observation. Hence, the proper imposition of the common support condition is of major importance for kernel matching method. A practical objection to its use is that it will often not be obvious how to set the tolerance. However, according to Mendola (2007), kernel matching with 0.25bandwidth is most commonly used. The question remains on how and which method to select. Clearly, there is no single answer to this question. The choice of a given matching estimator depends on the nature of the available data set (Bryson *et al*., 2002).

3.4.4.3. Checking overlap and common support

Imposing a common support condition ensures that any combination of characteristics observed in the treatment group can also be observed among the control group (Bryson *et al*., 2002).The common support region is the area which contains the minimum and maximum propensity scores of treatment and control group households, respectively. Comparing the incomparable must be avoided. Hence, an important step is to check the overlap and the region of common support between treatment and comparison group. One means to determine the region of common support more precisely is by comparing the minima and maxima of the propensity score in both groups. The basic criterion of this approach is to delete all observations whose propensity score is smaller than the minimum and larger than the maximum in the opposite group. Observations which lie outside this region are discarded from analysis (Caliendo and Kopeinig, 2008).

3.4.4.4. Testing the matching quality

Since we do not condition on all covariates but on the propensity score, it has to be checked if the matching procedure is able to balance the distribution of the relevant variables in both the control and treatment groups. The primary purpose of the PSM is that it serves as a balancing method for covariates between the two groups which differences in covariates are expected before matching that avoided after matching. Consequently, the balancing tests is to check whether the propensity score is adequately balanced or examine if at each value of the propensity score, a given characteristic has the same distribution for the treated and comparison groups. The basic approaches is to compare the situation before and after matching and check if there remain any differences after conditioning on the propensity score (Caliendo and Kopeinig, 2008). Rosenbaum and Rubin (1983), Dehejia and Wahba (2002), emphasized that it is to ensure whether the balancing condition is satisfied or not because it reduces the influence of confounding variables. There are different approaches in applying the method of covariate balancing between treated and non-treated individuals. Among different procedures the most commonly applied ones are described below.

Standard bias

One suitable indicator to assess the distance in marginal distributions of the X variables is the standardized bias (SB) suggested by Rosenbaum and Rubin (1985). It is used to quantify the bias between treated and control groups. For each variable and propensity score, the standardized bias is computed before and after matching as:

$$SB(X) = 100\frac{\overline{X}_1 - \overline{X}_0}{\sqrt{0.5(v_1(X) + v_0(X))}} \tag{16}$$

Where $\overline{X}_1$ and $\overline{X}_0$ are the sample means for the treatment and control groups, and $V_1(X)$ and $V_0(X)$ are the corresponding variance (Caliendo and Kopeining, 2008).

The bias reduction (BR) can be computed as:

$$\text{BR} = 100\left(1 - \frac{BX_{after}}{BX_{before}}\right) \tag{17}$$

One possible problem with the SB approach is that one does not have a clear indication for the success of the matching procedure.

T-test

A two-sample t-test used to check if there are significant differences in covariate means for both groups (Rosenbaum and Rubin, 1985). Before matching differences are expected, but after matching the covariates should be balanced in both groups and hence no significant differences should be found. The t-test might be preferred if the evaluator is concerned with the statistical significance of the results. The shortcoming here is that the bias reduction before and after matching is not clearly visible.

Joint significance and pseudo-R^2

Sianesi (2004) suggests re-estimating the propensity score on the matched sample of treatment and control groups, and comparing the pseudo-R^2 before and after matching. The pseudo-R^2 indicates how well the regressors' X's explain the participation probability.

After matching there should be no systematic differences in the distribution of covariates between both groups and therefore the pseudo-R^2 should be fairly low. Furthermore, one can also perform a likelihood ratio test on the joint significance of all covariates in the probit or logit model. The test should not be rejected before, and should be rejected after, matching. In this study case, in order to test the matching quality of matching estimators the combinations of the above procedures were applied.

3.4.4.5. Estimation of standard error

Testing the statistical significance of treatment effects and computing their standard errors has the problem that the estimated variance of the treatment effect should also include the variance due to the estimation of the propensity score, the imputation of the common support, and possibly also the order in which treated individuals are matched. These estimation steps add variation beyond the normal sampling variation (Heckman *et al.*, 1998).The standard errors in psmatch2 are invalid, since they do not take into account the estimation uncertainty involved in the score. One way to deal with this problem is to use bootstrapping as suggested by Lechner (2002).

Bootstrapping: This method is a popular way to estimate standard errors in case analytical estimates are biased or unavailable. Recently it has been widely applied in most of economic literature in impact estimation procedures. Each bootstrap draw includes the re-estimation of the results, including the first steps of the estimation (propensity score, common support). Bootstrap standard errors attempted to incorporate all sources of error that could influence the estimates.

Abadie and Imbens (2006), argue that using the bootstrap after nearest neighbor matching, until recently a common approach to estimating standard errors in evaluation studies, does not yield valid estimates .In other words, bootstrapping estimate of standard errors is invalid for nearest neighbor matching selection. Thus, calculating analytical standard error is applicable here. Bootstrapping standard errors for kernel matching estimators is not subject to this criticism because the number of observations used in the match increases with the sample size. The distribution of these means approximate the sampling distribution and thus the standard error of the population mean. Clearly, one practical

problem arises because bootstrapping is very time-consuming, computationally expensive and might therefore not be feasible in some cases (Caliendo and Kopeinig, 2008).

3.4.4.6. Sensitivity analysis

Recently checking the sensitivity of the estimated results becomes an increasingly important topic in the applied evaluation literatures (Caliendo and Kopeining, 2008).

Matching method is based on the conditional independence or unconfoundedness assumption, which states that evaluator, should observe all variables simultaneously influencing the participation decision and outcome variables. This assumption is intrinsically non-testable because the data are uninformative about the distribution of the untreated outcome for treated units and *vice versal* (Becker and Caliendo, 2007). As outlined in equation (5) that the estimation of treatment effects with matching estimators' is based on the unconfoundedness or selection on observables assumption. However, if there are unobserved variables which affect assignment into treatment and the outcome variable simultaneously, a 'hidden bias' might arise (Rosenbaum, 2002). In other word if treatment and outcomes are also influenced by unobservable characteristics, then CIA fails and the estimation of ATTs are biased. The size of the bias depends on the strength of the correlation between the unobservable factors, on the one hand, and treatment and outcomes, on the other.

It should be clear that matching estimators are not robust against this 'hidden biases. Different researchers become increasingly aware that it is important to test the robustness of results to departures from the identifying assumption. Since it is not possible to estimate the magnitude of selection bias with non-experimental data, the problem can be addressed by sensitivity analysis.

3.4.5. Variable selection

Another critical step before propensity score matching is choosing suitable covariates. Several aspects should be considered during this procedure. Sometimes, investigators are

accustomed to including numerous factors in the evaluation model. It is not always appropriate to do this. Including more variables significantly reduces the sample size due to more restricted conditions in propensity score estimation. The model becomes more sensitive when appropriate variables were selected. Investigators might question which variables may contain the information relevant to the researcher's interest, is the first point to start for variable selection.

Risk factors closely related to both treatment effect and the choice of treatment should be included. Adding these variables to the model usually reduces bias more than the variance it increases during matching. These factors form the 'minimum relevant' information set. If a variable affects only the participation decisions but not the treatment effect, it will not contaminate the performance of the treatment effect evaluation. On the other hand, if this factor affects only treatment effect but not the treatment selection, which means that this variable is identically distributed between treatment group and control group or does not exist at all, it will not introduce any selection bias into the evaluation process. The causal relationship among the covariates, outcomes or treatment variables should be derived from a theoretical bases and previous studies. Only those variables that fail in investigators' view can be excluded from the study. Interactions between factors, hierarchical items or spine smoothing are allowed to resolve the correlation among covariates when it is supported both the theoretically and statistically. It has been shown that inappropriate interaction may introduce bias in propensity score estimation. The variables affected by the treatment variables should be excluded to prevent the post-treatment bias and overmatching.

In addition, statistical criteria are also the elements to determine variables for matching. Those insignificant variables in the primary test might not have significant influence on outcome measures, but investigation after matching is also necessary. If there is general scientific consensus about which characteristics matter, matching should contain these covariates. It is critical to remember that outcome plays no role in propensity score estimation, only the covariates are involved. Two interesting methods were presented in the literatures for variable selection. The first is the "Hit or Miss Method" or Prediction Rate Metric, where variables are selected only if they maximize the within-sample correct prediction rates. The second approach relies on statistical significance and is very common in text book of econometrics. To do so, one starts with a parsimonious specification of the

model, such us constant, the age and some regional information, and then tests up by iteratively adding variables to the specification. A new variable is kept if it is statistically significant at conventional levels (Heckman *et al*., 1998a).

3.4.5.1. Dependent variable (Y_i)

The dependent variable for this study is participation into a program which takes the value of 1 if the household adopted an improved forage technology and zero otherwise.

3.4.5.2. Outcome variables

This study considers total income of a household from different sources (livestock sale, crop sale, off/non-farm activities, etc.) in Ethiopian birr as a measure of economic impact.

For objective two, other welfare indicators, such as household expenditures on education and health services in birr, consumption of food items in kilocalorie intake per-day/AE, job burden on women and time children spent on studying in hour per-day. To this effect, a comprehensive measure value of different items as purchased, produced, gift, received and imputed use value of household durable goods were incorporated.

1. Income: This refers to the total income from crops sell, livestock and their products sales and income generated from off/non-farm activities. Adoption of improved forage technology is hypothesized to increase total income of the households if total income increased from livestock seal is greater than 50%.

2. Expenditure on education: This is a continuous variable measured in birr that the households pay for education purposes for their children or even for themselves. This variable is hypothesized to be positively affected by improved forage practices as the improved forage adoption increases household income through their livestock products that the household may pay for education of their child and even for themselves.

3. Expenditure on health services: This is a continuous variable measured in birr that the

household pay for health services for their family. This variable is hypothesized to be positively influenced by improved forage practices as the improved forage adoption increases household income through their livestock products which they may pay for health services of their family.

4. Nutrition status of household (NUSHH): This is a continuous variable measured in kilocalories intake /AE that the household consumes during the survey year. This variable is hypothesized to have positively related to improved forage adoption. That is, as the income of household increases the consumption of household will also increase.

5. Women work time: This is a continuous variable measured in the total average hours that women work per-day. This variable is hypothesized to have positively related to improved forage practices as the improved forage adoption reduced burden of women work load because as female get forage in their field reduces the time that, women travel to collect livestock feed.

6. Time children spent on study per day: This is a continuous variable measured in the total average hours children spent on study per-day. This variable is hypothesized to have positively related to improved forage practices as the improved forage adoption reduces the time spent by children on livestock rearing.

3.4.5.3. Independent variables

1. Age of household head: It is a continuous variable measuring the age of the household head in years. As sited in the literature review, age of the household head might be related positively or negatively to the decision of technology adoption.

2. Education level of household head: It is a continuous variable measuring the grade level of formal schooling a farm household head has completed during the survey period. It is assumed that households' human capital is a key resource of income growth and an important trigger for wellbeing. Educational attainment by the household head could lead to awareness of the possible advantages of modernizing agriculture by means of technological inputs; enable them to read instructions on fertilizer packs and diversification of household incomes which, in turn, would enhance households' food

supply and livelihood improvement.

3. Family size: This is a continuous variable measured in the number of family members and expected to affect the household's adoption of this technology. This is because as total family size is the source of labor in the rural households, more family member means that proportionally, the number of active working group in that household is expected to be high. However, this might not hold true always for there are other reasons associated with family size. There are research findings like Pawlos (2002), which found that family size positively, affect the adoption of new technologies.

4. Active labor force: It is a continuous variable referring to the number of active labor force in the household, so that labor availability was one of the main important parameters which can influence the adoption of improved forage positively. On the other hand, large number of dependents negatively affects adoption of improved forage.

5. Attending demonstration day: It is a dummy variable that takes a value of 1 if household attended demonstration days of improved forage and 0 otherwise. That is, attending demonstration days will increase skill and awareness on the improved forage technology. It also creates access to information on the use of improved forage. Thus, it is hypothesized to influence adoption of improved forage positively.

6. Experience in fattening livestock: It is a continuous variable measured by the number of farming experience that the household head had in years. It is hypothesized to affect improved forage technology adoption because their experience they have on feeding their animals may increase adoption of improved forage.

7. Total cultivable land: It is a continuous variable expressed in terms of hectares of cultivable land. It is expected to have a positive effect on the adoption of the improved forage. This is because farmers who have more cultivable lands are expected to have enough land to cultivate improved forage for their livestock feed. This hypothesis is in line with the findings of Pawlos (2002) and Wagayehu (2003), where size of total cultivable land and area covered under crop positively and significantly influenced application of new technology adoption.

8. Extension visit: This is a continuous variable measured by the number of contact of the farmer with extension agent per-month. In this study, this variable is expected to affect adoption of improved forage technology positively. This is because extension intervention is expected to strengthen technology adoption and usage by the farmers.

9. Livestock holding (TLU): It is a continuous variable measured as the number of the market-oriented livestock that, the household is holding measured in Tropical livestock unit (TLU). The number of live animals the family is rearing has a positive contribution for improved forage adoption.

10. Access to credit: It is a dummy variable taking a value of one when the household has access to credit and zero otherwise. Access to credit is hypothesized to have a positive effect on technology adoption as it improves the financial capability of the farmer.

11. Market distance: It is a continuous variable measured as the distance in kilometer (km) that the household travel to reach the nearby market. Those farmers having access to agricultural market have better market information. It hypothesized to have a positive contribution to the adoption of improved forage.

12. Access to improved forage information: It is a dummy variable taking a value of one if the household has access to improved forage information and zero otherwise. It is hypothesized to affect adoption of improved forage positively

3.4.6. Computation of food calorie intake

As stated earlier, the impact of the improved forage technology development on the households' nutrition status was measured using physical consumption of food. To do so, households were asked to report the kind and amount of food items consumed by their families in the last two weeks preceding the survey. Converting the data into calories adjusted for household age and sex composition involved a series of steps. First, different units of local measurement were converted into a common measure for each food item. Second, the acquisition of each food item was converted to calories using the food composition table compiled by the Ethiopian Health and Nutrition Researches Institute (EHNRI, 2000). Third,

all food calories were added up and then converted to daily amounts. Finally, the aggregate food calories were adjusted in adult equivalent units (see Appendix 3) to make a meaningful household calorie intake.

Before proceeding to estimate the data using logit model, checking the existence of multicolinrarity between explanatory variables tests were undertaken. The Variance Inflation Factor (VIF) technique was employed to detect the problem of multicollinearity for the continuous variables VIF can be defined as; $VIF(X_i) = \frac{1}{1 - R_i^2}$ (18)

Where R_i is the squared multiple correlation coefficient between and other explanatory X_i variables. The larger the value of VIF, the more troublesome it is. As a rule of thumb if a VIF of a variable exceeds 10, the variable is said to be highly collinear.

Similarly, for dummy variables contingency coefficients test were employed using the following formula $C = \sqrt{\frac{X^2}{n + X^2}}$ (19)

Where C is contingency coefficient, is chi-square value X^2 and n = total sample size. For dummy variables if the value of contingency coefficients is greater than 0.75 the variable is said to be collinear. Heteroscedasticity exists when the variances of all observations are not the same, leading to consistent but inefficient parameter estimates. More importantly, the biases in estimated standard error may lead to invalid inferences (White, 1980). Heteroscedasticity was detected by using Breusch- Pagen test (hettest) in STATA.

Finally, the socio- economic impact of forage development on farm households livelihood were estimated, through, STATA 9.1 software using psmatch2 developed by Leuven and Sianesi (2003).

4. RESULTS AND DISCUSSION

In this chapter, both descriptive and econometric results are presented and discussed. The descriptive analysis employs the tools such as minimum, maximum, mean, percentage, standard deviation and frequency distribution. In addition, t-test and χ^2 statistics were employed to compare users and non-users of improved forage technology with respect to some explanatory variables.

Econometric analysis was conducted in order to analyze if there are significant livelihood differences between users and non users of improved forage technology and identify the socio-economic, demographic and institutional factors affecting participation. The study used PSM for identifying factors affecting participation in improved forage technology and whether there are significant differences between participants and non-participants in terms of the income and others social welfare indicators.

4.1. Results of Descriptive Analysis

Descriptive statistical analysis was run to observe the distribution of the independent variables. The socio-economic and institutional characteristics of the sampled households such as age, education level, family size, availability of labor, land holding, fattening experience, available information on improved forage, attending demonstration day of improved forage, market distance, extension visit, accesses to credit, livestock holding, were hypothesized to affect participation in the program in turn the outcome variables such as income from livestock seal, total income, women work time, child study time, health and education expenditure, calorie intake. 0f the total sample respondents interviewed 60 were users and the rest were non-users of improved forage technologies shown in the following summary statistics table 2.

Table 2. Summary statistics

Variable	Mean	Std.	Min	Max
Improved forage use	0.50	0.50	0	1
Age	41.38	8.96	26	65
Education	1.72	1.69	0	5
Family size	6.71	2.19	3	13
Active force	3.01	1.20	2	6
Land size	2.39	0.88	1	5
Information	0.62	0.49	0	1
Fattening experience	1.98	1.12	0	4
Market distance	4.43	2.05	1	7
Extension visit	2.72	1.05	1	5
Demonstration day	0.55	0.50	0	1
Access to credit	0.23	0.43	0	1
Livestock holding	6.55	2.52	0	10
Income from livestock	14392.7	9552.6	0	34000
Income from crops	2736.74	2069.03	0	10800
Off-farm income	2163.27	1194.97	0	5000
Total income	15551.8	8450.43	2400	37000
Women work time	10.65	1.36	8	13
Child study time	2.13	1.12	0	4
Health expenditure	172.32	186.55	0	1300
Education expenditure	411.28	692.38	0	5100
Calorie intake	2222.70	1351.44	1519.5	3147.7

Source: own survey 2010 result

4.1.1. Descriptive statistics and mean difference test between continuous variables

Descriptive results of continuous variables for the whole sample, participants and non-participants and mean difference test between participant and non-participants are presented in Table 3.

Table 3. Summary statistics and mean difference test between continuous variables

Variable	Non-users		Users		Total		t-value
	Mean	Std	Mean	Std	Mean	Std	
Age	41.07	8.87	41.71	9.13	41.38	8.96	-0.37
Education	1.38	1.69	2.05	1.63	1.72	1.69	2.2**
Family size	6.63	2.15	6.78	2.26	6.71	2.19	0.37
Active force	2.78	1.18	3.23	1.18	3.01	1.20	2.09**
Land size	2.2	0.84	2.58	0.89	2.39	0.88	2.43**
Fatten exp	1.58	1.20	2.37	0.88	1.98	1.12	4.08***
Mark dist	4.2	2.09	4. 67	2.00	4.43	2.05	1.25
Ext visit	2.58	1.05	2.85	1.06	2.72	1.05	1.39
Livestock	5.37	2.39	7.73	2.05	6.55	2.52	5.82***

Source: Own survey result

Note: **,*** significant at 5% and 1% probability level.

Descriptive statistics results show that there is no significant difference between participants and non-participants in terms of age, family size, market distance and extension visit. The average education level attained by the whole sample is 1.72 with. The average education level is 2.5 for users and 1.38 for non-users. The results indicate users attained higher level of education than non-users that there is significant difference in terms of educational attainment at 5% level. Regarding active force the results of the study indicate that the average active labor force is 3.23 for users and 2.78 for non-users that shows significant result at 5%. Regarding land holding on average total land holding of households is 2.39 with 2.58 ha for users and 2.2 ha for non-users shows significant at 5% probability level. Average fattening experience is 2.37 years for users and 1.58 years for non-users that, significant at 1% level and livestock holding result shows on average livestock holding were 7.73 for users and 5.37 for non-users. That shows significant in terms of livestock holding at 1% level.

4.1.2. Descriptive statistics and proportion difference test for dummy variables

The descriptive analysis of Pearson's chi-square proportion difference test between users and non-users for dummy explanatory variables shows a statistically significant difference

between users and non-users in terms of availability of information on the technology, attending demonstration days at 1% and access to credit at 5% probability level.

Table 4. Descriptive statistics and proportion difference test for dummy variables

Per-intervention variable	Category	Non-users		Users		Total		χ^2
		N	%	N	%	N	%	
Information	Yes	24	20	50	41.6	74	61.7	26.15***
	No	36	30	10	8.3	40	38.3	
Demonstration day	Yes	21	17.5	45	37.5	66	55	17.97***
	No	39	32.5	15	12.5	54	45	
Access to credit	Yes	6	5	22	18.3	28	23.3	12.64**
	No	54	45	38	31.7	72	76.7	

Sources: own survey result

Note: **, ***significant at 5% and 1% probability level

4.1.3. The distribution of livestock owned and sold

In the study area livestock such as cattle, shoat, camel, chicken, honey and livestock product like milk and butter are the main sources of livelihoods and income. Those, about 97.5% of households have livestock. On an average of about 86.6%, 52.5%, 4.2%, 16.7%, 7.5%, 89% and 4.9% of the households produced sold their cattle, shoat, camel, chicken, honey, milk and butters respectively as shown in (Table 5) respondent of each livestock produce sold of users and non-users were presented. With a monetary value of cattle 4500 to 9000 Birr, shoat**:** 400 to 1600 Birr, milk**:** sold on average of 4.5 birr per-liters were sold, chicken 15 birr to 25 birr, honey 45 birr per-kg and butters 50 birr per-kg. The results descriptive statics shows that, there is statistically significant difference between users and non-users in terms of cattle, shoat, milks and butters at 1%, honey at 5% and camel at 10% probability level. Thus, its indication shows that users of the technology are earning better income from livestock and their products sale compared to non-users.

Table 5. Distribution livestock sold by the sample households

Livestock Sold	Unit	Non-users			Users			Total (N = 120)		
		N	Mean	%	N	Mean	%	N	Mean Difference	t- value
Cattle	No	46	1.40	38.3	58	2.96	48.3	104	1.56	6.51***
Shoat	No	29	1.40	24.2	34	3.07	28.3	63	1.67	3.04***
Camel	No	4	0	0	5	0.07	4.2	9	0.07	1.86*
Chicken	No	11	0.74	9.2	9	0.95	7.5	20	0.21	0.204
Honey	Kg	3	1.31	2.5	6	5.42	5	9	4.11	2.0**
Milk	Lit	38	91.9	31.7	48	442.8	40	86	350.8	6.54***
Butter	Kg	14	3.58	11.7	35	23.90	29.2	49	20.32	6.49***

Sources: Own survey result

Note: *, **, *** significant at 10%, 5%, 1% level of significances respectively.

4.1.4. Mean difference test of the outcome variables

The outcome variables for socio- economic impact of improved forage development on households' livelihoods are presented in Table 6.

Table 6. Mean difference test of the outcome variables for users and non-users

Variable	Unit	Non-users		Users		t-value
		Mean	Std	Mean	Std	
Total income	Birr	10182.02	5180.98	20921.6	7651.2	9.0***
Income from livestock	Birr	5926.21	4415.05	15241.1	9511.44	9.10***
Income from crop	Birr	1929.03	900.56	2865.26	1871.87	4.81***
Off-farm income	Birr	2048.62	1975.85	1895.65	1583.54	-0.075
Calorie intake	Kcal/AE	1959.31	1463.90	2567.43	1183.1	2.17**
Women work time	Hours	11.45	1.08	9.85	1.13	-7.92***
Child study time	hours	1.52	1.02	2.75	0.86	7.19***
Health expenditure	Birr	116.05	99.96	228.58	231.87	3.45***
Education expenditure	Birr	228.8	348.20	593.75	882.01	2.98***

Source: Own survey result

Note: **, *** significant at 5% and 1% probability level

The average total income is 20921.63 birr for users and 10182.02 birr for non-users income from livestock seal is 15241.1 birr for users and 5926.21 birr for non-user and

income from crop is 2865.26 birr for users and 1929.03 birr for non-users. Result shows there is statistically significant difference in terms of total income, income from livestock and income from crops at1% level.

Furthers more results show that average income of users is much higher than non-users and taking into account only livestock income of households, then income of users is more than twice the income of non-users and the change in households income is more related to change in income of livestock. Though, there is no significant difference in terms of income from off/non-farm income. This result might be related to the unavailability of off/non-farm job opportunity in the study area. The average health expenditure is 228.58 birr for users and 116.05 birr for non-users and education expenditure is 593.75 birr for users and 228.8 birr for non-users. There is significant difference in terms of health and education expenditure at1% level

The average kcal/ AE intake is 2567.43 for users and 1959.31 for non-users. There is statistically significant difference in terms of the household nutritional status of kilocalorie intake/ AE at 5% level. The USDA has fixed the average calorie requirement for Ethiopia at 2088 cal per day per adult equivalent. This is a very rough generalization, but a useful reference. On the other hand, technological change and commercialization of smallholder agricultural production improves the level of food consumption of participating households (von Braun and Kennedy, 1994). This as evident for this study as the adoption of improved forage increases consumption of nutritional status of households.

The average hours that women work per- days is 9.85 hours for users and 11.45 hours for non-users and children study is 2.75 hours for users and 1.52 hours for non-users There is statistically significant difference in terms of time worked by women and children study per-day at1% level. This indicates that adoption of improved forage reduces the burden on women and increased children study time. Previous research results on school time of children revealed that providing services which are sustainable and replicable through the adoption of low-cost, community–managed simply applicable training technologies by means of community empowerment reduce the work load on women and children also improve education time of children (UNICEF, 1994a).

4.2. Econometric Results

Econometric analysis is conducted to analysis factors affecting participation and its impact on income from livestock seal, total income, calorie intake, women work time, students school time, expenditures on health and education. Propensity score matching procedure was used to analyze through STATA software 9.1. In this process, choice of best estimator based on certain indicators and balancing tests was conducted to improve quality estimate.

4.2.1. Logit model determinants of forage adoption

By employing the binary logit regression model the important variables explaining participation in improved forage technology adoption for market-oriented livestock production were identified. The results show that out of the twelve explanatory variables which were hypothesized to affect participation in improved forage adoption and which in turn affects the outcome variables only eight variables were found to be statistically significant. These include age, family size, active labor force, experience in fattening, distance to market, information about the technology, attending demonstration day and livestock holding. Age, family size and market distance significantly and negatively affect improved forage technology adoption, whereas active labor force, experience in fattening, attending demonstration days, availability of improved forage information and livestock holding affects it positively (Table 7).

Table 7. Logistic regression results for improved forage adoption

Improved forage use	Coefficients	Std. Err.	z	P>|z|
Age	-0.076*	0.044	-1.73	0.084
Education	-0.038	0.18	-0.21	0.83
Family size	-0.38*	0.20	-1.93	0.05
Active force	1.03**	0.41	2.55	0.02
Land size	-0.25	0.35	-0.75	0.46
Information	1.54***	0.58	2.68	0.00
Fattening experience	1.04***	0.31	3.12	0.00
Market distance	0.24*	0.14	-1.74	0.08
Extension visit	0.15	0.31	0.49	0.62
Demonstration day	1.25**	0.57	2.20	0.02
Access to credit	0.50	0.74	0.67	0.50
Livestock holding	0.42***	0.15	2.80	0.01
Constant	-4.83***	1.73	-2.60	0.01
LR chi2(12) =	72.97			
Prob > chi2 =	0.0000			
Log likelihood =	46.69			
Pseudo R^2 =	0.4387			
Number of obs =	120			
On support	109			

Source: own survey result

Note: *, **, *** significant at 10%, 5%, 1% probability level

In the logistic regression the common support condition is imposed and the balancing property is set and satisfied in all the regressions at 1% significance level.

The reason for the positive contribution of those variables on the dependent variable and indirectly on the outcome variables could be those farmers having more experience in fattening, higher active labor force, high accumulation of livestock in terms of tropical livestock unit, access to improved forage information, attending improved forage demonstration days will ease participation in the adoption of improved forage technology. This contributes for increasing the production and productivity of livestock and their products and hence improvement in their livelihoods.

4.2.2. Matching estimate of propensity score

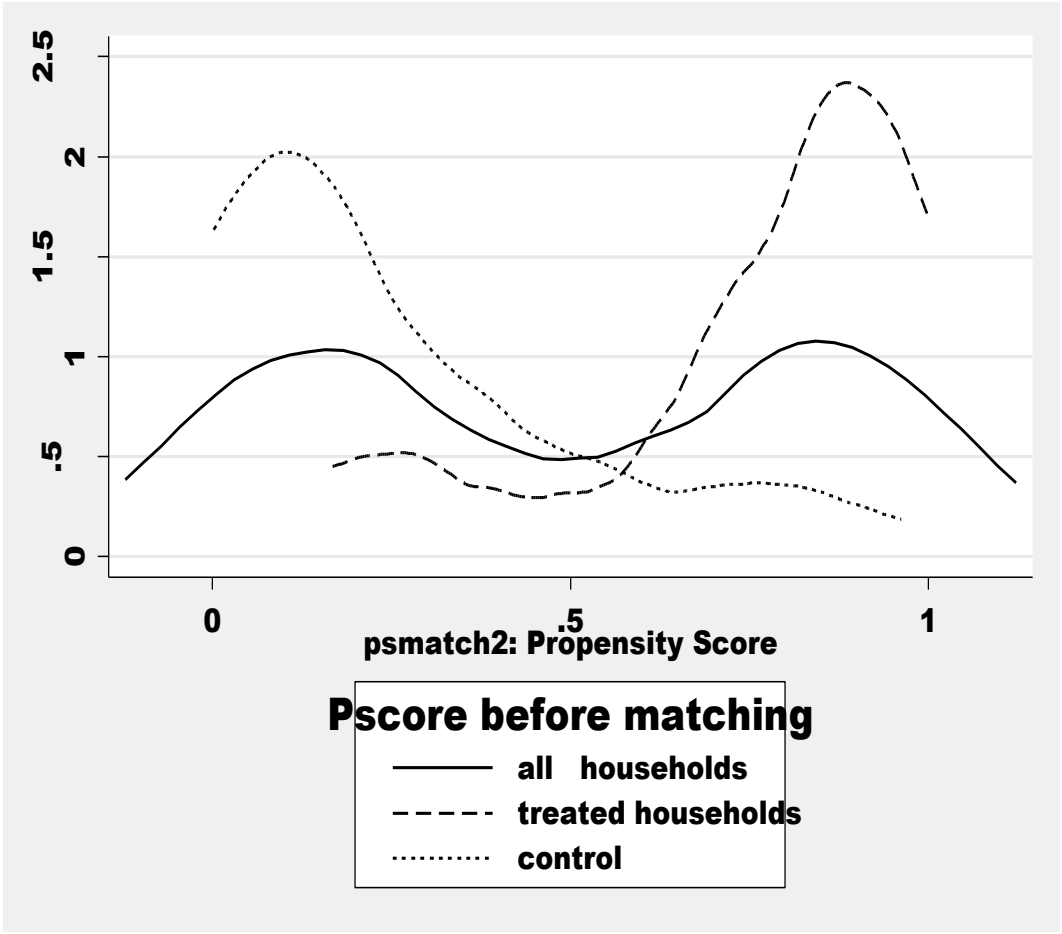
As shown in Table 8, the estimated propensity scores vary between 0.168 and 0.998 with mean of 0.752 for improved forage users or treatment households and between 0.002 and 0.960 with mean of 0.248 for non-improved forage users (control) households. The common support region would then lie between 0.168 and 0.960. In other words, households whose estimated propensity scores are less than 0.168 and larger than 0.960 are not considered for the matching exercise.

Table 8. Distribution of estimated propensity scores

Group	Obs.	Mean	St. Dev.	Min	Max.
Total households	120	0.5	0.358	0.002	0.998
Treatment households	60	0.752	0.250	0.168	0.998
Control households	60	0.248	0.258	0.002	0.960

Source: Own survey result

The below Figure 2, portrays the distribution of the households with respect to estimated Propensity score, in case of treatment most households are found in partly the middle and partly in the right side of the distribution. On the other hand, most of the control households are partly found in the center and partly in the left side of the distribution



Figures 2. Kernel density of propensity score distribution

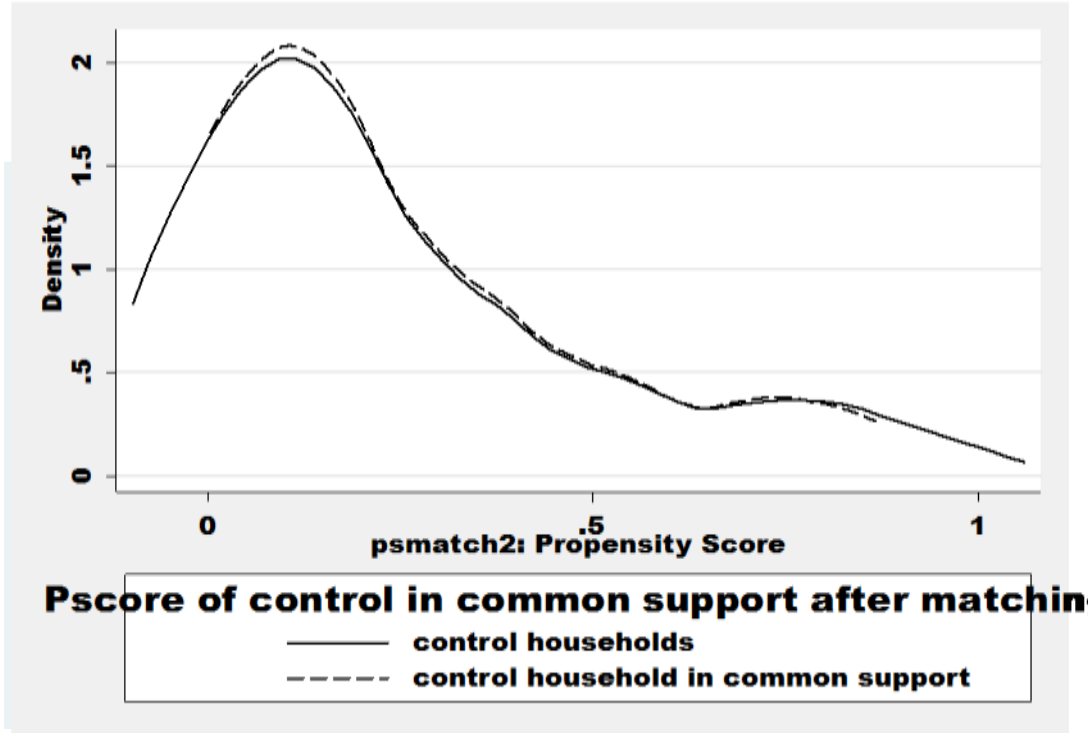


Figure 3. Kernel density of propensity scores of non-participant households

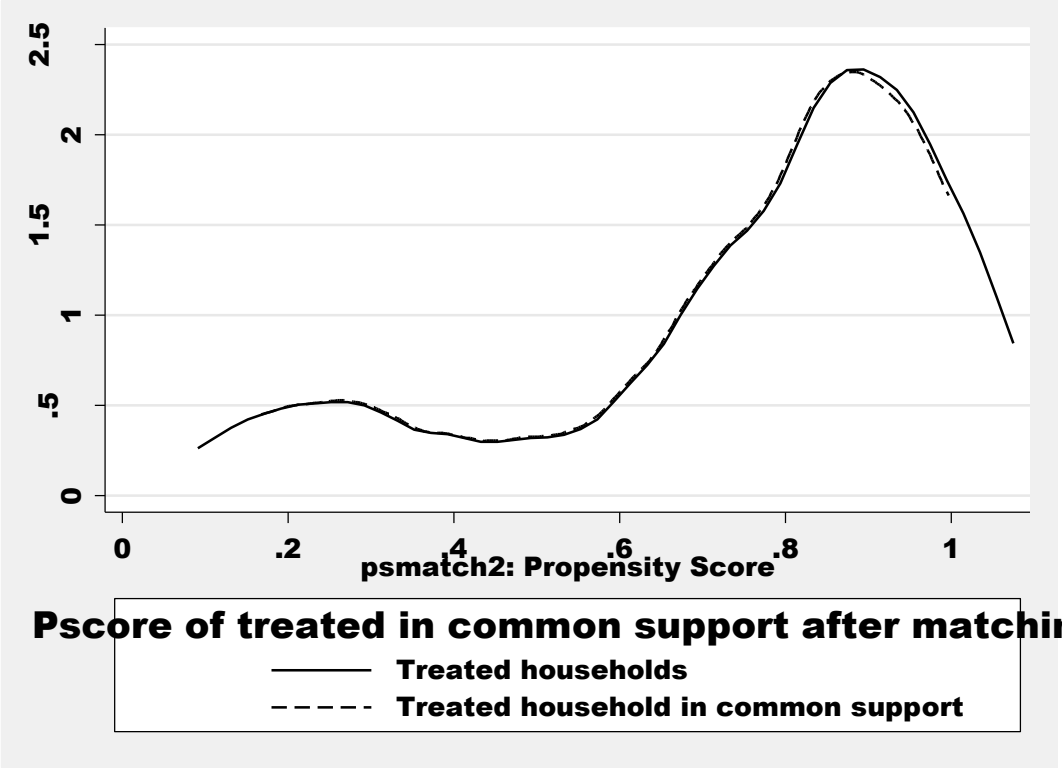


Figure 4. Kernel density of propensity scores of participant households

4.2.3. Matching estimation procedure: some results

Prior to non-parametrically estimate the technology impact, we need to well specify the propensity scores for treatment. Estimated p-score results for the improved forage adoption are aimed at checking whether our cross-sectional matching estimators are sensitive to the choice of a particular sub-sample, the common support condition is imposed and balancing propensity is set and satisfied in all regressions at1% significance probability level.

We used logit model to predict the probability to adopt the improved forage technology and we include different ranges of household characteristics as regressors. Results of three different matching algorithms are reported in Table 9 and are useful in order to check the consistency of the estimated causal effect, which may be affected by the set of exogenous variables used to estimate the p-score (Smith and Todd, 2003).

Table 9. Performance of matching estimators

Matching estimators	Performance criteria		
	Psedo-R^2	Insignificant variables	Sample size Matched
Nearest Neighbor Matching (NNM)			
Neighbor without replacement	0.321	9/13	109
Neighbor with replacement	0.092	10/13	109
Nearest Neighbor with caliper(0.3)	0.073	12/13	109
Radius caliper matching (RCM)			
Radius (0.01)	0.209	11/13	81
Radius (0.25)	0.073	12/13	109
Radius (0.5)	0.112	10/13	109
Kernel Matching (KM)			
Kernel (0.1)	0.053	13/13	109
Kernel(0.25)	0.067	12/13	109
Kernel(0.5)	0.073	11/13	109

Source: Own survey result

As the most recent literature indicated alternative matching estimators are tried in matching the treatment and control households in the common support region. The final choice of a matching estimator was guided by different criteria such as pseudo-R^2 tests, insignificant number of variables after matching and matched sample size. Thus, a larger set of variables and matched sample size with smallest pseudo-R^2 were preferred in that it makes less likely that the unobservable remain out of the matching process. Estimated p-score results for the improved forage development on cross-sectional matching estimators are sensitive to the choice of a particular sub-sample. As presented in Table 9, the matching sample size of radius caliper (0.01) were 81, while the rest of all eight matching estimators are equal to 109 but there are difference in insignificant variables that NNM with replacement, NNM with caliper and kernel matching bandwidth (0.10), (0.25), (0.50), and radius caliper (0.01), (0.25), (0.50) has, 10, 12, 13, 12, 11, 11, 12 and 10 insignificant variable after matching respectively. Thus, only the KM with bandwidth 0.10 has large number of insignificant variables (13) that selected in this case. Also, the results in Table 9 show that KM with bandwidth (0.1) has the smallest pesedo-R^2 which is 0.053. Therefore, KM with bandwidth (0.1) is selected as it fulfills all the three criterion of best matches' estimator.

4.2.4. Balancing test

The t-test suggests that differences in household characteristics between the treatment and control groups are jointly insignificant both before and after matching. In the individual covariates balancing tests (Table10), the number of variables with no statistically significant mean difference were NNM without replacement, NNM with caliper 0.3, KM matching with band width 0.1, 0.25, 0.5, radius caliper 0.5, 0.25 and 0.01 matching have insignificant variable after matching is 10, 12, 13, 12, 11, 11, 12 and 10 respectively. Hence, KM with band width 0.1 matching has larger 13 insignificant variables after matching, the smallest 0.053 psedo-R^2 and 109 matched samples. Then, KM with band width 0.1 is chosen as the best estimators' of the average treatment effect, because it satisfied all the three matching performance criteria (lower pseudo R^2 value, higher number of covariates with insignificant mean difference between the two groups and larger number of matched sample size). Consequently, only the outcomes from this estimator are used to meet the study objectives of estimating the socio-economic impact of forage development on the farm households livelihood income and others social welfare in the study area.

Table 10. Balancing test of covariates' with different algorithms

No	Variable	Sample unmatched	Sample after KBM(0.25)	KM (0.10)	Sample after C Radius (0.25)
1	Age				
	Mean(treatment)	41.68	41.02	41.2	41.02
	Mean(control)	41.08	39.21	39.68	39.58
	t-test(p value)	0.37	-1.04	-0.79	- 0.81
2	Education level				
	Mean(treatment)	2.05	2.	2	2
	Mean(control)	1.38	2.25	2.32	2.28
	t-test(p value)	2.20**	-0.75	-0.97	-0.82
3	Family size				
	Mean(treatment)	6.78	6.49	6.49	6.49
	Mean(control)	6.63	6.49	6.49	6.55
	t-test(p value)	0.37	0.01	0.00	0.41
4	Active labor force				
	Mean(treatment)	3.23	2.96	2.96	2.96
	Mean(control)	2.78	2.97	3.04	2.99
	t-test(p value)	2.08**	-0.04	-0.37	-0.11
5	Information				
	Mean(treatment)	0.83	0.80	0.80	0.80
	Mean(control)	0.40	0.82	0.84	0.80
	t-test(p- value)	5.41***	-0.33	0.56	0.08
6	Land cultivated				
	Mean(treatment)	2.58	2.55	2.55	2.55
	Mean(control)	2.20	2.58	2.55	2.53
	t-test(p value)	2.43**	-0.15	0.00	0.11
7	Fatting experience				
	Mean(treatment)	2.37	2.33	2.33	2.33
	Mean(control)	2.58	2.13	2.15	2.13
	t-test(p value)	4.08***	1.03	1.00	1.03
8	Distance to market place				
	Mean(treatment)	4.67	4.33	4.33	4.33
	Mean(control)	4.20	4.50	4.60	4.48
	t-test(p value)	1.25	-0.42	0.67	-0.37
9	Demonstration day				
	Mean(treatment)	0.73	0.69	0.69	0.69
	Mean(control)	0.37	0.69	0.74	0.66
	t-test(p value)	4.31***	0.07	-0.47	0.34
10	Extension visits HH/month				
	Mean(treatment)	2.85	2.78	2.78	2.78
	Mean(control)	2.58	2.67	2.63	2.62
	t-test(p value)	1.39	0.49	-0.65	0.72
11	Accesses to credit				
	Mean(treatment)	0.37	0.31	0.31	0.31
	Mean(control)	0.1	0.13	0.18	0.13
	t-test(p value)	3.61***	2.10**	1.40	2.13*
12	Tropical livestock unit				
	Mean(treatment)	7.73	7.33	7.33	7.33
	Mean(control)	5.37	6.81	7.00	6.74
	t-test(p value)	5.82***	1.15	0.73	1.28
	Psedo-R^2	0.4387	0.067	0.053	0.073
	Numbers observation	120	109	109	109
	N(Treatment)	60	49	49	49
	N(Control)	60	60	60	60

*, **, *** significant at 10%, 5%, and 1% probability level.

Hence, only KM bandwidth (0.1) fulfills all the three criteria listed above. Thus, this study has chosen KM bandwidth (0.1) matching methods as the best estimators then we run the ATT estimation with this best choice estimator.

Table 11. Propensity score and covariate balance

		Mean		%reduct		t-test	
Variable	Sample	Treated	Control	%bias	|bias	t	p>|t
_pscore	Unmatched	.75209	|.2479	198.5		10.87	0.000
	Matched	.70167	|.6953	2.5	98.7	0.12	0.901
Age	Unmatched	41.683	41.083	6.7		0.37	0.716
	Matched	41.02	39.657	15.2	127.3	-0.79	0.430
Education level	Unmatched	2.05	1.3833	40.2		2.20**	0.030
	Matched	2	2.3166	-19.1	52.5	-0.97	0.336
Family size	Unmatched	6.7833	6.6333	6.8		0.37	0.710
	Matched	6.4898	6.4889	0.0	99.4	0.00	0.998
Active labor	Unmatched	3.2333	2.7833	38.1		2.08 **	0.039
	Matched	2.9592	3.0433	-7.1	81.3	-0.37	0.998
Land size	Unmatched	2.5833	2.2	44.3		2.43 **	0.017
	Matched	2.551	2.5518	-0.1	99.8	-0.00	0.997
Forage Information	Unmatched	.83333	|.4	98.7		5.41***	0.000
	Matched	.79592	|.8399	-10.0	89.8	-0.56	0.577
Fatting Experience	Unmatched	2.3667	1.5833	74.5		4.08***	0.000
	Matched	2.3265	2.1454	17.2	76.9	1.00	0.322
Market distance	Unmatched	4.6667	4.2	22.8		1.25	0.214
	Matched	4.3265	4.5997	-13.4	41.5	0.67	0.502
Extension visit	Unmatched	| 2.85	2.5833	25.4		1.39	0.167
	Matched	2.7755	2.6277	14.1	44.6	0.65	0.520
Demonstration days	Un matched	.73333	.36667	78.6		4.31***	0.000
	Matched	.69388	.73673	9.2	88.3	-0.47	0.642
Accesses to credit	Unmatched	.36667	0.1	65.9		3.61***	0.000
	Matched	.30612	.18448	30.1	54.4	1.40	0.165
TLU	Unmatched	7.7333	5.3667	106.2		5.82 ***	0.000
	Matched	| 7.3265	7.0034	14.5	86.3	0.73	0.470

Sources: own estimation results
Note: **,***,5% and !% significant differences level

All of the above tests suggest that the matching algorithm we have chosen is relatively best with the data we have at hand. Thus, we can proceed to estimate ATT for households.

4.2.5. Treatment effect on the treated (ATT)

In this section, the thesis provides evidence as to whether or not the socio-economic impact of forage development on the farm households livelihood have brought about significant change on household income and social welfare issue (health, education, and nutritional status, job burden of women and school time of children). The estimation result presented in Table 12 provides a supportive evidence of statistically significant difference at different levels between participants and non-participants in terms of the total household income, expenditures on health and education services measured in birr, nutritional status measured in calorie intake/AE as well as job burden of women measured in the hours women are working per-day and school time of children measured in hours children of respondent households study per-day. The analysis was done after controlling for pre-intervention differences in demographic, location, institutional and asset endowment characteristics of the improved forage technology users and non-users households.

Table 12. Average treatment effects on treated (ATT)

Variable	Treated	Controls	Difference	S.E	T-stat
Total income	20384.94	14373.97	6010.97	1931.97	3.11***
Income from livestock	14392.7	9552.64	4840.06	1570.45	3.08***
Income from crop	2736.74	2069.03	667.70	442.80	1.51
Off-farm income	1995.65	2048.62	-52.97	542.52	0.075
Calorie intake	2567.43	2653.84	- 86.41	495.94	-0.17
Women work time	9.94	10.74	-1.50	0.36	2.26**
Children study time	2.74	1.51	1.22	0.32	3.78***
Health expenditures	215.20	107.59	107.61	46.63	2.31**
Education expenses	592.35	368.51	223.83	167.13	1.34

Source: own survey result

Note: **, *** significant at 5% and 1% probability level.

4.2.6. PSM improved forage impact on households' income

The main objective of propensity score matching as stated in the methodology part is that it arguably improves the ability of regression to generate accurate causal estimates by

virtue of its non-parametric approach to the balancing of covariates between the treatment and control group, which removes bias due to observable variables. Therefore, by using binary logit regression model taking participation in improved forage as a dependent variable, the socio-economic impact of forage development on the farm households on the outcome variable (total income and income from livestock seal) was analyzed and interpreted as follows:

In the case of matching, the number of significant variables affecting participation and the outcome variables were eight variables. In addition the result after matching indicates that out of 60 participants, 11 households were dropped from the matching process of kernel matching with bandwidth (0.1) which indicates that they are either outliers or unmatched with the characteristics of non-participants in common support selection hypothesis. as shown in Table12.

The results from the propensity score after matching shows that there is statistically significant difference in income between improved forage technology users and non-users holding all other factors constant before intervention among two groups. Overall the results obtained after controlling for treatment effects of KM bandwidth (0.1) matching technique matched regression model (ATT) it has been found that, on average, improved forage adoption has increased physical income of participating households by 6010.97 birr, which is approximately higher by about 41.81% than non-participants. This provides a supportive evidence of statistically significant effects of the improved forage technology adoption on households income measured in Ethiopian birr at1% probability level. Participated households income from livestock seal were increased physically by 4840.06 shows statistically significant at1% probability level, income from crop seal for participants physically increased with mean difference of 667.7 birr significant at 10% probability level and income from off/ non-farm activity were for participants and for non-participants with mean difference of -53.97 and not significant. Though if we take only income from livestock seal to ratios of the households total income physical increments on average about 80.5% change come from livestock seal income. Therefore we can says change in households income is the results of improved forage technology on livestock products. Hence, the study results provide evidence that directly achieving production enhancements in poor rural households in livestock farms through better targeting of technological programs, have an important causal impact on household income. This result

is consistent with the descriptive analysis results and other empirical studies. Therefore, the result of the study is sufficiently helpful for drawing policy recommendations for further intervention in the subject area by policy makers and other concerned bodies.

4.2.7. Results of PSM forage impact on households livelihood

In this study, PSM is also used to assess socio-economic impact of forage development on the farm households' livelihood of the social issues (calorie intake/AE, expenditures on education and health, women working and student study time. Results show that improved forage technology adoption have significant positive impact on households expenditure on health, reducing women working time and increasing student study time. The discussions for the significant variables will be given below

4.2.7.1. Impact on women's working time

As a number of time-budget studies indicate that tasks such as livestock feed collection can account a part of an adult women's extremely long working day as would the reduction of laborious food processing operations through the introduction of labor and time saving technologies can improve women work burden (UNESCO, 1985). Then based on this literature the study conduct analysis the survey data result.

The results from the propensity score after matching in **(**Table 12) shows that there were statistically significant differences in women's job burden of improved forage technology users and non-users by holding other factors constant before intervention. Overall the results obtained after KM with bandwidth (0.1) matching technique matched regression model (ATT) it has been found that, on average decreased job burden of participating household's women by 1.50 hours, which is approximately near to 13.97% differences. This provides supportive evidences of statistically significant at 5% probability level.

4.2.7.2. Impact on children study time

The results from the propensity score after matching (Table 12) shows that there is statistically significant difference in average improves children school time of respondent households participated. Overall result has been found that, on average has increased study time of children participated households by 1.22 hours per-day, which is approximately 80.79% higher than children's study time of non-participating households. That provides evidence of statistically significant impact at1% probability level. This might true since improved forage technology adoption reduced time children rearing livestock which increases the time that children spent on studying.

4.2.7.3. Impact on expenditure on health

The results from the propensity score after matching shows that there is statistically significant difference in expenditures on health services of participated households. Overall the results had been found that, increased physical health expenditures by 107.61 Ethiopian birr, which is statistically significant impact at 5% probability level.

In the end it is important to note that adoption of improved forage have no significant impact on expenditure on education and nutritional status of the households may be because pastoralists gave less emphasis to education and that since the products are mostly for markets there might not be significant difference between the two groups in terms of nutritional status.

4.2.8. Sensitivity analysis result

In order to control for unobservable biases (Table.13) presents the critical level of e^{γ} (first column), at which the causal inference of significant socio-economic impact of forage development on the farm households' livelihood has to be questioned. As noted by Hujer *et al.* (2004), sensitivity analysis for insignificant effect is not meaningful and is therefore not considered here. Given that the estimated improved forage development for market-oriented livestock production effect is positive for the significant outcomes, the lower

bounds under the assumption that the true treatment effect has been underestimated were less interesting (Becker and Caliendo, 2007) and therefore not reported in this study. Rosenbaum bounds were calculated for socio-economic impact of forage development on the farm households' livelihood outcome effects that are positive and significantly different from zero. The first row of the table shows those outcome variables which bears statistical difference between treated and control households in our impact estimate above. The rest of the values which corresponds to each column of the significant outcome variables are p-critical values (upper bound of Wilcoxon significance level-Sig+) at different critical value of e^{γ}

Table 13. Result of sensitivity analysis using Rosenbaum bounding approach

Gamma	Outcome			
	Health expense	Children study	Women work load	Total Income
$e^{\gamma} = e^{\gamma} = 1$	P<0.002	P<1.0e-0	P<0000	P<9.7e-06
e^{γ} =1.25	P<0.000	P<1.3e10	P<5.0e-07	P<3.2e=07
e^{γ} = 1.5	0.000	1.6e-12	1.8e-08	1.0e-08
e^{γ} =1.75	1.7e-06	2.1e-	6.2e-10	3.5e-10
e^{γ} =2	1.4e-07	2.2e16	2.2e-11	1.1e-11
e^{γ} =2.25	1.2e-08	0	7.7e-13	3.8e-13
e^{γ} =2.5	9.9e-10	0	2.7e-14	1.3e-14
e^{γ} =2.7	8.2e-11	0	1.0e-15	4.4e-16
e^{γ} =3	6.8e-12	0	0	0

Source: own estimation

Note: e^{γ} (Gamma) = log odds of differential due to unobserved factors where Wilcoxon significance level for each significant outcome variables is calculated

Result show that the inference for the effect of socio-economic impact of forage development on the farm households' livelihood is not changing though the participants and non participant households has been allowed to differ in their odds of being treated up to 200% (e^{γ} =3**)** in terms of unobserved covariates**.** That means for all outcome variables estimated, at various level of critical value of e^{γ} , the p-critical values are significant which further indicate that we have considered important covariates that affected both

participation and outcome variables. We couldn't get the critical value e^{γ} where the estimated ATT is questioned even if we have set e^{γ} largely up to 3 which is larger value as compared to the value set in different literatures which is usually 2 (100%). Thus, we can conclude that our impact estimates (ATT) are insensitive to unobserved selection bias and are a pure effect of socio-economic impact of forage development on the farm households' livelihood outcomes by IPMS project.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study analyzed socio-economic impact of forage development on the farm households' livelihood by descriptive statics and propensity score matching procedure. The livelihood outcome variables include total household income from (livestock sell, crop sell and off/non-farm activity income), social issue/welfare (expenditure on education, expenditure on health, nutrition status in kilocalorie intake per-AE, work load of women and study /school time of children. The result of the descriptive analysis shows that there is a significant difference in all the outcome variables between users and non-users of improved forage technology which indicates an improvement in the livelihood of farmers participating in the program.

The result from regression proves that about five explanatory variables which include active labor force, information on improved forage technology, fattening experience, attending improved forage demonstration day, livestock holding are positively affect the participation of households in improved forage technology. This means that those farmers have more experience on livestock fattening, has more labor force in households, has access to improved forage information, attending improved forage demonstration days and high accumulation of livestock in terms of tropical livestock unit are more likely to adopt the technology. This might contributes for increasing the production and productivity of livestock and their products of farming household which in turn improves the livelihood of the poor farmers.

Regression results also show three variables namely age, family size and market distance significantly affect the adoption of improved forage negatively. These results might be related to the fact that older farmers lack information about the technology or labor or are resistant to new technologies, farm households with large family size might lack the financial to buy input animal which raise capability to adopt forage and those who far from markets might lack information about technology and hence, less likely to adopt.

Propensity score matching results show that, improved forage has significant positive impact on participated households' income, women working time, students' study time and expenditure on health services. Results further show that, on average, improved forage adoption has increased physical income of participated households by 6010.97 birr, which is approximately higher by about 41.81% than non-participants. Regarding women's working time participation in program reduced women working time by 1.50 hours which is about 13.97% less than non-user households' women working time. This result might be that improved forage technology adoption enable them to get livestock feed from their field which reduced time women devote for livestock feed collection from elsewhere.

The results of PSM show that the study time of users' households' children increased by 1.22 hours (40.46%) than non-user households' children. This might be due to the fact that most rural households' children's activity are rearing livestock, if get feeds in their field might be consume student's study time.

Regarding health expenditure, the PSM result shows that participation in the program increases expenditures on health services by 107.61 birr than non-participants. This might be related to the fact that adoption of this technology increases their income which can partly goes to health services.

Result of sensitivity analysis also show that the inference for the effect of the improved forage development were not change though the participants and non participant households has been allowed to differ in their odds of being treated up to 200% (e^{γ} =3**)** in terms of unobserved covariates**.** Thus, we can conclude that our impact estimates (ATT) are insensitive to unobserved selection bias and are a pure effect of socio-economic impact of forage development on farm households' livelihood outcomes by IPMS project.

5.2. Recommendation

Based on the findings of this study the following recommendations can be drawn:

1. Age has a significant negative impact on the adoption of improved forage. This might be because of the fact that aged people lack labor or information or being resistant to new technologies. Therefore, targeting younger households or

providing the necessary information for the older ones is required to enhance the adoption of this technology.

2. Family size and distance to the market have a significant negative impact on the adoption of improved forage. Moreover, active labor force was found to have a significant positive impact. The latter result is related to the fact that the technology is labor intensive and hence, need to target households with large number of active forces bring about desired outcome. Therefore, focus on the households training on family planning and infrastructure development should be recommended.

3. Information about the technology, attending demonstration days and experience in fattening were found to enhance the adoption of this technology. These indicate the need for further work on awareness creation about the technology.

4. In addition, the result of logit model showed total cultivable land has a positive impact on the adoption of improved forage. The reason for this may be that household heads with relatively large land size may produce enough on their existing plots and may have less desire to expand their landholding by encroaching adoption of forage. So, focus on increasing small land size holder household land size should be recommended.

5. Livestock holding (TLU) has shown a positive and significant influence on the probability of adopting improved forage technology. Therefore, focus on households with large herd size or building the livestock base for those who have less number through credit access are needed to enhance the adoption of technology.

   Finally socio-economic impact of forage development on the farm households' livelihoods is found to have a significant impact on increasing households' income, reducing job burden of women, increasing students study time and increasing households' health expenditures. These show the importance of this technology in improving the livelihood of the poor farmers.

6. REFERENCES

Abadie, A. and Imbens, G.W., 2006. Large sample properties of matching estimators for Average Treatment Effects. *Econometrica*, 74:235- 67.

Adams, M. E., 1992. Agricultural extension in developing countries. Intermediate Tropical Agricultural Series

Adesina, A. A. and Chianu, J. 2000. Determinants of farmers' adoption and adaptation of alley farming agro forestry technology in Nigeria. Paper presented at the international workshop on "Understanding Adoption Processes of Natural Resource Management Practices for Sustainable Agricultural Production in Sub Saharan Africa", 3-5 July 2000 at the International Center for Research on Agro forestry, Kenya.

Adesina, A. A. and Zinnah, M.M. 1993. Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. *Agricultural Economics*, 9: 297-311.

Amare Berhanu, 2005. Determinants of formal source of credit loan repayment performance of smallholder farmers: the case of North Western Ethiopia, North Gondar. An M.Sc. Thesis Presented to school of graduate studies of Haramaya University.

Andersson, C., Alemu Mekonen and Stage S., 2009. Impacts of the productive safety net program in Ethiopia on livestock and tree holdings of rural households. Discussion Paper Series. Environment for Development (EfD) Initiative. EfD DP 09-05.

Aregay W., 1979. Assessment of the diffusion and adoption of agricultural technologies in Chilalo. *Ethiopian Journal of Agricultural Science*, 1: 51-66.

Atkinson, R.L., Atkinson, R.C., Smith, E. E. and Hilgrad, E. R.1985. Introduction to psychology. New York, Harcourt, Brace Javonovich, Pp. 181-207.

Baker, J.L., 2000. Evaluating the impact of development projects on poverty: A handbook for Practitioners. Washington D.C. World Bank.

Becker, S. O. and Ichino, A., 2002. Estimation of average treatment effects based on Propensity Scores *The Stata Journal*, 2(4): 1-19.

Bekele Hundie, Verkuijl, H., Mwangi, W. and Tanner, D., 2000. Adoption of improved wheat technologies in Adaba and Dodola Woredas of the Bale highlands, Ethiopia. Mexico, International Maize and Wheat Improvement Center (CIMMYT) and Ethiopian Agricultural Research Organization (EARO).

Belay Kebede, 1998. Agricultural credit and factors impeding loan repayment performance of Smallholders in West Shewa: The case of Alemgena Woreda. An M.Sc. Thesis Presented to School of Graduate Studies of Haramaya University.

Berelson B. and Steiner, G. A., 1964. Human behavior: An inventory of scientific findings. New York: Harcourt, Brace and World, Inc. Pp. 87-121.

Berhanu Gebremedhin and Hoekstra, D., 2007. Cereal marketing and household market participation in Ethiopia: The case of teff, wheat and rice. Proceedings of the (2007) 243-252 Conference of the AAAE. International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia.

Berhanu Gebremedhin, Hoekstra, D. and Azage Tegegne, 2006. Commercialization of Ethiopian agriculture: Extension service from input supplier to knowledge broker and facilitator, IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 1. ILRI (International Livestock Research Institute), Nairobi, Kenya.

Bryson, A., Dorsett, R. and Purdon, S., 2002. The use of propensity score matching in the evaluation of labor market policies. Working Paper No. 4. Department for Work and Pensions.

Central Statistical Authority (CSA) (2009). Statistical Abstract. CSA, Addis Ababa
The Contribution of Livestock to the Ethiopian Economy – Part II Roy Behnke Odessa Centre Great Wolford United Kingdom Fitaweke Metaferia Senior Expert, National Accounts Directorate, Ministry of Finance & Economic Development (MOFED), Ethiopia.IGAD LPI Working Paper No. 02 - 11

Caliendo, M., and Kopeinig, S., 2008. Some practical guidance for the implementation of propensity score matching. IZA Discussion Paper No. 1588, University of Cologne.

Chilot Yirga, Shapiro, B. T. and Mulat Demeke, 1996. Factors influencing adoption of new wheat technologies in the Wolemera and Addis Alem Areas of Ethiopia, Ethiopia. *Ethiopian Journal of Agricultural Economics*, 1: 63-84.

CIMMYT(International Maize and Wheat Improvement Center), 1993. The adoption of agricultural technology: A guide for survey design. CIMMYT Economics Program, CIMMYT, Mexico, D. F.

Dasgupta, S., 1989. Diffusion of Agricultural Innovations in Village India. Wiley Eastern Limited, New Delhi, India.p.376-83.

Davidson, R. and MacKinnon,J. G. 1999. Foundation of econometrics. Oxford Press.

Dawit A., Mwangi, W., Mandefro N. and David, J. S., 2008. The maize seed system in Ethiopia: Challenges and opportunities in drought prone areas. *African Journal of Agricultural Research*, 3(4): 305-314.

Day, B., James, T., Kozma, R. B., Milller, J., Wagner, D. A. and Unwin, T., 2005. A Monitoring and evaluation of ICT in education projects: A Hand book for Developing Countries, *an info Dev publication www.Infodev.Org.* The International Bank for Reconstruction and Development/The World Bank 1818 H Street, N.W, Washington, D.C.200433 U. S.A.

De Groote H., Doss, C., Lyimo, S.D. and Mwangi, W., 2002. Adoption of maize technologies in East Africa: What Happened to Africa's emerging Maize Revolution? Paper presented at the FASID Forum V, "Green Revolution in Asia and its Transferability to Africa". 8-10 December, Tokyo, Japan.p.32.

de Janvry, A., Fafchamps, M. and Sadoulet, E., 1991. Peasant household behavior with missing markets: Some paradoxes explained. *Economic Journal*, 101:1400-1417.

Dehejia, R. H. and Wahba, S., 2002. Propensity score matching methods for non experimental causal studies. *The Review of Economics and Statistics*, 84(1):151-161.

Doss C. R., 2003. Understanding farm level technology adoption: lessons learned from CIMMYT's micro surveys in Eastern Africa. CIMMYT Economics Working Paper 03-07. Mexico, D.F., CIMMYT.

EHNRI (Ethiopian Health Nutritional Research Institute), 2000. Food consumption table for use in Ethiopia, part III, Addis Ababa.

FAO (Food Agriculture Organization), 2000. Impact assessment of agricultural research: Context and state of the art. Revised version of a paper prepared by the Impact Assessment and Evaluation Group (IAEG) of the Consultative Group on International Agricultural Research (CGIAR) for the ASARECA / ECART / CTA. Workshop on impact assessment of agricultural research in Eastern and Central Africa. Rome, Italy.

FAO (Food and Agriculture Organization), 1985. Study on landless and near-landless. FAO, Rome.

FAO (Food and Agriculture Organization), 1996. Rural informal credit markets and the effectiveness of policy reform. Economic and Social Development Paper Rome.134.

Feder G. R., R. E. Just R.E and Zilberman, D., 1985. Adoption of agricultural innovations in developing countries: A survey. *Economic Development and Cultural Change*, 33:25.297.

Gilligan, D., Hoddinott, J. and Alemayehu Seyoum, 2008. The impact of Ethiopia's Productive Safety Net Programme and its linkages. IFPRI Discussion Paper 00839.

Gryseels, G. and Anderson F.M., 1983. Research on farm and livestock productivity in the central Ethiopian highlands, Initial results; 1977-1980. International Livestock Research Center for Africa, Addis Ababa, Ethiopia. P52.

Gujarati, D. N., 2003. Basic econometrics, Fourth Edition. McGraw Hill, New York.

Gujarati, D.N., 1995. Basic econometrics, Third Edition. McGraw Hill Inc, New York.

Harper, J. K., Rister, M.E., Mjelde, J.W Dress, B.M and Way, M.O., 1993. Factors influencing the adoption of insect management technology. *American Journal of Agricultural Economics*, 75: 997-1005.

Heckman, J. and Robb, R., 1986. Alternative method for solving the problem of selection bias in evaluating the impact of treatment on outcomes, in H Weimar (ed.), Drawing Inferences from self-selected samples (New York: Spring - Verlag).

Heckman, J., Ichimura, H. and Todd, P., 1998. Matching as an econometric evaluation estimator. *Review of Economic Studies*, 65: 261-294.

Heckman, J. and Navarro-Lozano, S., 2004. Using matching instrumental variables and control functions to estimate economic choice models. *Review of Economics and Statistics*, 86: 30-57.

Heckman, J., LaLonde, R. and Smith, J., 1999. The economics and econometrics of active labor market programs. In O. Ashenfelter and D. Card (eds), *Handbook of Labor Economics*, (Vol. III, pp. 1865–2097). Amsterdam: Elsevier.

Heckman, J., Smith, J. and Clements, N., 1997. Making the most out of social experiments: Reducing the intrinsic uncertainty in evidence: From randomized trials with an application to the National JTPA Experiment. *Review of Economic Studies*, 6*:* 487-535.

Holland, P., 1986. Statistics and causal inference. *Journal of the American Statistical Association*, 81(396): 945–960.

Hossain, M., 1989. Green revolution in Bangladesh: Impact on growth and distribution of income. University Press Ltd, Dhaka.

Hossain, M. and Sen, B., 1992. Rural poverty in Bangladesh: Trends and determinants. *Asian Development Review*, 10: 1–34.

Hossain, M., Quasem, M.A., Akash, M.M., Jabbar, M.A., 1994. Differential impact of modern rice technology: the Bangladesh case. In: David, C., Otsuka, K. (Eds.), Modern Rice Technology and Income Distribution in Asia. Lynn Reinner Publishers, Boulder, CO.

Hossain, S.M.A., Chamala, S., 1994. Patterns and intensity of adoption of the HYVs of bororice in Bangladesh. *Bangladesh Journal of Agricultural Economics*, 17 (1/2): 45–60.

Ichino, A., 2001. Problema della Causalita`. Una Introduzione Generale ed un Esempio. Capitolo20. In: Luchino Brucchi (Ed.), Manuale diEconomia del Lavoro, Bologna, Il Mulino.

IFAD (International Fund for Agricultural Development), 2000. Rural poverty report 2000/200. IFAD, Rome.

IFAD (International Fund for Agricultural Development), 2001. Federal Democratic Republic of Ethiopia Rural Financial Intermediation Program, Report No. 1241-ET.

ILRI (International Livestock Research Institute), 2009. People, livestock and environment: Project overview and rationale.V.4. ILRI, Addis Ababa, Ethiopia.

IWP (International Water Projects), 1996. Monitoring and evaluation guidelines for World Bank GEF. International water series paper number 037

Jalan J., and Ravallion,M., 2003. Does piped water reduce diarrhea for children in rural India? *Journal of Econometrics*, 112: 153–173.

Jalan, J. and Ravallion, M., 1999. Income gains to the poor from workfare: Estimates for Argentina's Trabajar Program. Indian Statistical Institute and World Bank. Policy Research Working Paper 2149. Washington, DC.

Kenea Yadeta, 1997. Uncertainty and resource use on small-scale farmers in Ada area, Eastern Showa: With special emphasis to crop production. An MSc Thesis presented to School of Graduate studies of Alemaya University. 111p.

Koutsoyiannis, A., 1997. Theory of econometrics: An introductory exposition of econometric methods. 2nd ed. Macmillan Publishers Ltd, USA.

Kumar, K., 1989. Indicators for measuring changes in income, food availability and consumption, and the natural resource base. A.I.D. Program Design and Evaluation Methodology Report No. 12. Washington, D.C.: U.S. A.I.D., September 1989.Helpful discussion about indicators for assessing impact of agricultural and rural development program.

Lechner, M, 2002. Program heterogeneity and Propensity Score Matching: An application to the evaluation of active labor market policies. *The Review of Economics and Statistics*, 84 (2): 205-220.

Lelissa Chalichissa, 1998. The determinants of adoption, intensity and profitability of fertilizer use. The case of Ejere district, West Shoa Zone. M.Sc. Thesis, Addis Ababa University, Addis Ababa, Ethiopia.

Main, B., Reilly, B., 1993. The employer size-wage gap: Evidence for Britain. *Economica*, 60 (238): 125–142.

Maureen, N. and Sharon, P.B., 1987. Guidelines for data collection, monitoring and evaluation plans for A.I.D.-assisted projects, A.I.D. Program Design and Evaluation Methodology Report No. 9., Washington, D.C., U.S. A.I.D., April 1987. For additional information on preparing monitoring plans.

Mendola, M., 2007. Agricultural technology adoption and poverty reduction: A propensity score matching analysis for rural Bangladesh. *Journal of Food Policy,* 32(3):372-393.

Michael, B. Mackay, K. and E., Ooi, 2004. Influential evaluations: Evaluations that improved performance and impacts of development programs. Washington, D.C.: Operations Evaluation Department, the World Bank.

Milano, A., 2006. Agricultural technology adoption and poverty reduction: a propensity-score matching analysis for rural Bangladesh. *Food Policy*, 32: 372–393.

Minale Kasse, 1997. Economics of food crops-forage legumes integration in mixed farms of the Ethiopian highlands. An MSc Thesis presented to School of Graduate Studies of Alemaya University.

MOA's (Ministry of Agriculture), 1997. Development Program Plan, Addis Ababa, Ethiopia.

MOARD (Ministry of Agriculture and Rural Development), 2005. Development Program Plan. Addis Ababa, Ethiopia.

MoFED (Ministry of Finance and Economic Development), 2002. Sustainable Development and Poverty Reduction Program. Addis Ababa Ethiopia.

MPLSDPD (Mieso Pilot Site Diagnosis and Program Design), 2007. Mieso pilot learning site diagnosis and program design.(Improving Productivity and Market Successes of Ethiopian farmers Mieso Pilot Learning Woreda, 2007. Survey data Mieso, Ethiopia.

NABC (Netherlands-African Business Council), 2010. Fact Sheet: Livestock Ethiopia Livestock in Ethiopia and opportunity analyses for Dutch investment September 2010 NABC

Nssah, B., 2006. Propensity score matching and policy impact analysis. Poverty reduction group. World Bank. Washington, D.C.

Wuletaw Belayneh, 2000. Economics of urban dairying in Hawassa town Southern Nations, Nationalities and Peoples Regional State. An M.Sc. Thesis presented to School of Graduate Studies of Haramaya, University.

Spielman, D. J. and Bernard, T., 2008. International Food Policy Research Institute mobilizing rural institutions for sustainable livelihoods and equitable development: A case study of farmer cooperatives in Ethiopia: An overview Addis Ababa, Ethiopia.

Yibeltal Fentie, 2008. The impact of Ibnat-Belessa integrated food security program on household food poverty. An M.Sc. Thesis Presented to School of Graduate Studies of Haramaya University. 94p.

Yishak Garedew, 2005. Determinants of adoption of improved maize technology in Damote Gale Woreda, Wolaita Ethiopia. An M.Sc. Thesis presented to the School of Graduate Studies, Haramaya University. 122p.

Yitayal Anley, 2004. Determinants of use of soil conservation measures by smallholder farmers in Jimma Zone. The case of Dedo district, Ethiopia. An M.Sc. Thesis presented to the School of Graduate Studies, Haramaya University. 97p

Storck, H., Bezabih Emana, Berhanu Adnew, Borowiecki, A. A and Shimelis W/Hawaryat, 1991. Farming system and farm management practices of smallholders in the Hararghe highlands. Faming system and resource Economics in the Topics.11: Wissenschfts Varlag Vauk Kiel KG, Germany.

Tesfaye Zegeye, Girma Taye, Tanner, D., Ver kuijl, H., Aklilu Agidie and Mwangi, W., 2001. Adoption of improved bread wheat varieties and inorganic fertilizer by small-scale farmers in Yelmana Densa and Farta Districts of North western Ethiopia. Mexico, D.F.: Ethiopian Agricultural Research Organization (EARO) and International Maize and Wheat Improvement Center (CIMMYT). p.14, 17-22.

TGE and UNICEF (Transitional Government of Ethiopia and United Nations Children's Fund), 1994a. Master plan of operations for basic services of children and women, 1994-1999 country program of co-operation between the GOE and UNICEF, Addis Ababa.

UNICEF (United Nations Children's Fund), 1986. Framework for improvement of the monitoring and evaluation, of child survival and development activities. CF/EXD-IC-5 March 1986.

UNPFA (United Nations Population Funding Agencies), 2004. Program manager's planning, monitoring and evaluation toolkit division for oversight services. August 2004 Tool Number 5: Planning and Managing an Evaluation Part 1 p3-6.

WB (World Bank), 2005. Influential evaluations: evaluations that improved performance and impacts of development programs. Washington, D.C. www.worldbank.org/oed/ecd/

Wendmsy Amregne, 2004. Socio-economic determinants of child malnutrition in the rural areas of Harari National Regional state of Ethiopia. An M.Sc Thesis presented to the School of Graduate Studies of Haramaya, University.

Wubeneh Nega, 2003. Farm level adoption of new sorghum technologies in Tigray Region, Ethiopia. USA, Purdue University. M Sc Thesis.

Smith, J., Todd, P., 2003. Does matching overcome LaLonde's critique of non-experimental estimators? *Journal of Econometrics*, 1251–1252.

Omiti, J., Otieno, D., Madelon, M., Nyanamba, T. and Murage,A., 2006. Participatory prioritization of issues in smallholder agricultural commercialization in Kenya, Discussion Paper No. 64, Kenya Institute for Public Policy Research and Analysis (KIPPRA), Nairobi.

Omoto, W., 2003. Impact assessment of urban agriculture research and development in Nairobi, Kenya. Department of Research and Development, Kenya. Nairobi.

Paulos Asrat, 2002. Determinants of farmers' willingness to participate in soil conservation practices in the highlands of Bale: the case of Dinsho farming system area. An M.Sc. Thesis submitted to the school of graduate studies Haramaya University.

Peter, H. B. R and Roger, N. D., 1986. Mathematical programming for economic analysis in agriculture. Macmillan Publishing Company, New York.

Ponniah, A. and Martella, D. R., 1999. Evaluation of agricultural research in Eastern, Central, and Southern Africa. *Knowledge, Technology and Policy*: *Winter,* 11(4):13-41.

Ponniah, A., Martella, D. R. and Rukuni, M., 1996. A training manual on R & D evaluation and impact assessment of investments in agricultural and natural resources research, SACCAR, Gaborone, Botswana.

Ravallion, M., 2005. Evaluating anti-poverty programs. Policy research working paper 3625, World Bank, Washington D.C.

Reardon, T. and Timmer, C. P., 2005. Transformation of markets for agricultural output in developing countries since 1950: How has thinking changed? In R.E. Evenson, P. Pingali and T.P. Schultz (eds). Handbook of Agricultural Economics Volume 3. Agricultural Development: Farmers, Farm Production and Farm Markets. Amsterdam: Elsevier.

Rogers E.M., 1962. Diffusion of innovation. New York Free Press, New York, p.376.

Rosenbaum, P. R and Rubin, D. B., 1983. Central role of the propensity score in observational studies for causal effects. *Biometrica,* 70 (1): 41-55.

Peter H. and Freeman, H. E., 1982. Evaluation: A systematic approach. Second edition, California: SAGE Publications, Inc.

Rover, T. and Dixon, R., 2007. Operational guidelines for assessing the impact of agricultural research on livelihoods. Good practices from CIMMYT. Impacts Targeting and Assessment (ITA) Unit. Mexico.

Rubin, D. B., 1974. Estimating causal effects of treatments in randomized and non randomized studies. *Journal of Educational Psychology*, 66: 688–701.

Sianesi, B., 2004. An evaluation of the active labor market programs in Sweden. *The Review of Economics and Statistics*, 186(1):133-155.

Smith, J. and Todd, P., 2005. Does matching overcome Lalonde's critique of non–experimental estimators? *Journal of Econometrics*, Volume?125 (1-2): 305-353.

7. APPENDICES

7.1. Conversion Factors

Appendix Table 1. Conversion factors for livestock unit

No	Livestock type	TUL (Tropical livestock unit)
1	Calf	0.20
2	Heifer	0.75
3	Cows/oxen	1.00
4	Young bull	0.80
5	Donkey	0.70
6	Young donkey	0.35
7	Sheep/Goat	0.13
8	Sheep /Goat(young)	0.06
9	Camel	1.25
10	Chicken	0.013

Sources: Storck *et al*., 1991

Appendix Table 2. Conversion factor for computing calorie intake

Food item	Unit	Calorie	Food item	Unit	Calorie
Wheat	Kg	3574	Beef	Kg	1148
Teff	Kg	3589	Milk	litter	737
Barely	Kg	3723	Butter	Kg	7363
Lentil	Kg	3522	Egg	No	61
Hose bean	Kg	3514	Honey	Kg	3605
Sorghum	Kg	3805	Pepper	Kg	933
Peas	Kg	3553	Maize	Kg	3560
Vetch	Kg	3470	Millet	Kg	3260
Linseed	Kg	5109	Check pea	Kg	3630
Sugar	Kg	3850	Garlic	Kg	118
Coffee	Kg	1103	Edible oil	Kg	8964

Source: FHNRI 2000

Appendix Table 3. Conversion factor for adult equivalent (AE)

Age group	Male	Female
< 10	0.6	0.6
10-13	0.9	0.8
>13	1	0.75

Source: Storck *et al*., 1991

7.2. Household Questionnaire

HARAMAYA UNIVERSITY

Survey Questionnaire Used for

Socio-economic impact of forage development on the farm households' livelihoods **in Mieso District, West Hararghe**

ID. Identification /General Information

1. Questionnaire number __ 2.Interviewer's name_____ 3.Date of interview_____ 4. Name of (PA) _____ 5. Distance to nearest road? ____ km 6. Distance to nearest market_____ km 7. Distance to nearest health ___km 8.Distance to extension services ____km 9. Distance to nearest school ____km 10. Distance to water supply __km

A. Personal Background Details

11. Respondents name (household head) _____11.1.Age____11.2 Sex_ 12. Marital status ____1.single, 2.married, 3.divorced, 4. Widowed 13. Family size ____,14. Education level of household _____ 15. Have you participated in some informal social organization in the community? (1) Yes (0) No, 16. Farming experience since started farming _____ years. 17. What is your main occupation currently? _____ Do you have another occupation other than farming? (1)Yes (2) No If yes, in what type of activity you have been engaged?_____ (1) Petty trading (2).Handicrafts (3)Others, specify_____ 18. What is the type of house you own and live in? _____(1)Thatch roofed (2)Corrugated tin roofed

B. General Farm Structure

B1. Livestock owned (during January 2001- 2002 EC) to be obtained from table C1

B2. Farm land and others assets (during January 2001- 2002 EC)

19. How much is the total size of the land (farm size) in tima

No	Farm type	Number of plots	Allocated to grazing	allocated to annual crops	allocated to tree crops	Homestead area	Total size	Unit value in Birr	Total value in Birr
1	Own								
2	Leased- in								
3	Leased–out								
4	Others								

20. The types of cultivated crops grown

No	Types of cultivated crops grown last year	Number of pilot	Area cultivated in timad	Production cost in birr	Yield in kg per hectors	Unit value in birr	Total value in birr
1	Maize						
2	Sorghum						
3	Improved forage plant						
4	Improved forage seed						
5	Others specify						

21. How many of your family members do permanently work on farm? Number family worker graters than 14 years Male___, Female_____

C. Livestock Production and Marketing

C1. Livestock Inventory

22. What livestock types and number do you own? During Jaunary2001- 2002 EC production period

No	Animal type	Beginning		Incoming			Out going					Ending balance		Remarks
		No	value	Born	Purchase	gift	Sold		slaughtered	Dead	Gif	Thief	No	Value	
							No	Up							
					No	unit									
1	Cow														
2	Bull														
3	Heifer														
4	Calf														
5	Ox														
6	Horse														
7	Mule														
8	Donkey														
9	Camel														
10	Goat														
11	Sheep														
12	Poultry														
13	Bee colony														

No= number UP= unit prices

C2. Input use in Livestock production:

C2.a. Input use in dairy production:

23. Are you engaging in dairy production? (1) Yes, (2) No If yes fill the table below

No	In put type	Frequency provision	Amount at one time provided		Unit value (Birr)	Total value per yrs(Birr)	No of dairy using input	Remarks
			Only	unit				
1	**Fodder/forage**							
2	**Concentrate**							
3	**UMB**							
5	**Salt/salt- bar**							
6	**Roughage**							
7	**"Atela "**							
8	**Drugs**							
9	**Veterinary services**							
11	**Bull services**							
12	**Labor input**							
13	**Housing cost**							

C2.b. Input use in fattening:

24.Are you engaged in fattening practices? (1)Yes, (0) No. If yes, fill the input used in table below

No	Livestock type	No of animals fattening 2001 EC	How long you started?	Where you buy a	Average Prices Birr/a	Where you seal	Average prices Birr/a	long stay to fattening/mth	Expenses on average keeping animals for fattening				
									Feed O P	Drug	Vet. services	Initial purchase	labor O H
1	Ox												
2	Bull												
3	Cow												
4	Sheep												
5	Goat												
6	Camel												
7	Others												

O= own, P= purchase, H= herring, a= animals

C2. c. Input use in Apiculture production:

25. Are you engaging in apiculture production? (1)Yes, (2) No If yes, fill table below

No	Apiculture input type	Traditional beehives	Transitional beehives	Modern beehives
A	Number of beehives owned			
B	Number of beehives with bees by then			
C	Average honey harvest per hive(kg) per year			
D	Percentage of honey sold from each hive			
E	Average prices of honey per kg from each			
F	Bee forage cost (Birr)			
G	Cost of bees wax (Birr)			
H	Cost of supplementary feed during off season			

C2. Livestock input markets

26. Livestock input markets availability during January 20001-2002EC

No	Input type	Does market exist?	Where exist?1=FG 2=LM 3=DM 4=RM	Who provider1=FR2=TR3=MOA4=CP 5=OT	Average prices	Quality input	Remark
a	Feed market 1.fodder/forage/straw 2. concentrate 3. UMB 4. salt - bar						Per kg
b	Health 1. Drugs 2. Vet. services						P/services >>
c	Breeding stocks 1. Heifers/cows 2. Bulls 4. Goat 5. Hen/cock 6. Bee colony						Per-an.

FG=farm gate LM=local market DM=District market RM= Regional market FR=Farmers, TR=Traders/privet input suppler, MOA=Ministry of agriculture, CP=Cooperative, OT= others

C5. Livestock output market

27. Livestock output market availability during January 2001-2002 E.C.

No	Output type	Market place 1FG 2.LM 3.DM4.RM	Does market exists?1Yes2 No	Buyers 1. consumer 2.farmers 3.Assembler 4.Wholesealer 5.processor	Distance of homesteads		Adequacy buyer in market? 1bad 2 moderate 3 good	Do you have contract?	Means of transport	Remark
					km	Walking minutes				
A	Dairy output									
	1.fluid milk									
	2.Butter									
B	Fattening									
	Ruminant									
	1small									
	2.Large									
C	1chicken									
	2 Egg									
D	1 Honey									
	2 Bee wax									
	3 bee colony									

28. Livestock output market participation (January, 2001- 2002 EC)

No	Commodity type	Unit measurement	Produce year 2001-2002 EC	Consumed	Gift	sold		Market places				Type of buyer % purchased by each							Remarks
						Q	TV	FG	LM	DM	CP	FR	AS	WS	RT	PR	UC	CP	
A	Dairy Output																		
	1. fluid Milk	Liters																	
	2. butter	Kg																	
	3Youghurt	Kg																	
B	1. Chick en	No																	
	2 Egg	No																	
C	1. Honey	kg																	
	2. beeswax	kg																	
	3.bee colony	hives																	
D	fattening																		
	1.small ruminant																		
	2.Large ruminant																		

FG=farm gate, LM=local market, DM=district market, RM=Regional market FR=farmer AS=assembler WS=wholesaler, RT=retailer, PR=processor, CP=cooperate, UC=Urban consumer, Q= quantity animals sold, TV = Total value of animals sold

D. IMPROVED FORAGE DEVELOPMENT

29. Have you ever planted improved forage? _____(1)Yes, (0) No
30. On how many different pilot grow improved forage (pilot can be filed/ fences)__Number
31. What is the size of the pilot? _____a. Hector per-filed, b. meter per-fence
32. Which cropping system you adopted? _____Name intercropping in% of each a=monoculture b=intercropping c= hedge d=others*
33. When did you start growing on this pilot? _____Years
34. did you have information about improved forage?_____ (1) Yes (o) No
35. What propagation methods did you used?_____ (a) =seeds (b)=seedling (c)=cutting (d)others specifies
36. Why did you decide to try it? _____ Because (1)Its drought resistance (2)its high productivity (3)Others specify_____
37. If no, used why not you use improved forage? _____ (1) Seed not available (2)Not heard introduction of it in to this area (3) Not good for feed for animals (4)Depletes the soil (5)Not good for traditional feeding for animal (6)Current market price is not attractive (7)Others
38. If you know improved forage how do you compare with substitute local grass? _____(1)Better (2) Inferior (3)No change Human labor use
39. Improved forage compare to sorghum residue or maize?_____ (1)Yield (2) Drought resistance (3)Disease resistance (4) Early maturity (5)Weed resistance
40. If you plants improved forage it use for what purpose?_____(1)seal (2)feed for animal, (3)gives to others person (4)others specifies _
41. If you compare feeding to yours animals its yields betters for what products?_____(1) Dairy (2) Fattening (3)others specifies_____
42. If you feed for dairy estimate milk products litters per- day? _____
43. If you feeds for fattening animals what yours product 2001 to 2002 EC? (1)oxen__(2)cattle____(3)Sheep__(4)Goat__(5)Camel__(6)others specifies _____
44. If you seals yours improved forage planted what you get from it in years 2001 to 2002 EC, Value of sold in birr _____
45. Would you meet animals feed consumption requirement from your own production? (1)Yes (2) No
46. Have you increase market-oriented livestock product since, growing improved forage?__ (1)Yes, (2) No
47. If yes, what are the types of livestock product that you have sold?_____ (1) Live animals (cattle __Goat__ sheep__ camel __ etc.) (2)Milk ____liters (3)Butter _kg (4)Others specifies _____

E1. Extension support services

48. Did you contact with DA during the last crop season?_____(1)Yes, (2) No
49. Have you ever attended any field demonstration day of improved forage? _____ (1)Yes (2) No
50. Did your family members training on Improved Forage? (1)Yes (2)No
51. Did you get any extension support in buying input?_____ (1)Yes (2)No
52. Did you get any extension support in selling output?_____(1)Yes (2)No

E2. Credit Availability

53. Did you receive credit service during last production season? __(1)Yes, (0) No.

54. If yes, for what purpose you use the loan?_____ (1) Both improved forage and fertilizer (2)Fertilizer only (3)Improved forage seed only
55. From which agency did you borrow? (a)= Union (b) = micro credit (c)=National Banks(d)=Development Banks (e)= Cooperative (f)= Friends (g)= others _____

E3. Labor availability

56. On which types of farm activity your female family members participated? (1)Weeding (2) Harvesting (3)Plough (4)Trashing (5)livestock feed collection(6)Others specify ___
57. On which activities do children lees than 14 years involves? _____
58. How many hours your female work per days?_____
59. How many hours your student children study per days?_____

F. On and Off-farm income

F1. Farm Income: Main sources of income? 1. Crop sale ___2.Livestock sale__ 3. Off-farm income_

F2. Non-farm income

60. Household income from non-farm activities

No	Sources	Time attending in activity	Amount (Birr)
1	Daily laborer on construction or others non-farm activity		
2	Self employment in manufacturing		
3	Salary or pension		
4	remittance		
5	Trade		
6	Income from land rent		
7	Income from renting other propriety		
8	Aid		
9	Charcoal or firewood sale		
10	Gift		
11	Handicraft activity		

G. Household consumption expenditure

61. .Household consumption expenditure during January 2001-2002 EC Consumable items food and other household stuff purchased fees paid for health, education and others before 15 days of surveys period

No	Agriculture items	Purchased				Remarks
		Unit	quantity	Unit price	Total prices	
A	Cereals					
a1	Teff					
a.2	Maize					
a.3	Wheat					
a.4	Barley					
a.5	Sorghum					
a.6	Rice					
a.7	Others					

B	Pulses
b.1	Beans
b.2	Peas
b.3	Chickpea
b.4	Vetch
b.5	Others
C	Oilseeds
c.1	Nough
c.2	Sesame
c.3	Rapeseed
c.4	Others oilseed
D	Fruits and vegetable
E	coffee
F	Dairy product
G	Others specify

No	Non-agricultural items	Purchased				
		Unit	quantity	Unit prices	Total prices	Remark
H	Household stuff					
h.1	Sugar					
h.2	Oil					
h.3	Salt					
h.4	Kerosene					
I	Household furniture's					
J	Cloths					
K	Telephone					
L	Implement equipment					
l.1	Farm Implement,					
l.2	Farm equipments					
l.3	Household equipment					
M	Services fee					
m1	Education fee					
m2	Health services					
m3	Land tax					
m4	Land rent					
m5	contribution					
m6	Others fee					

71